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1929
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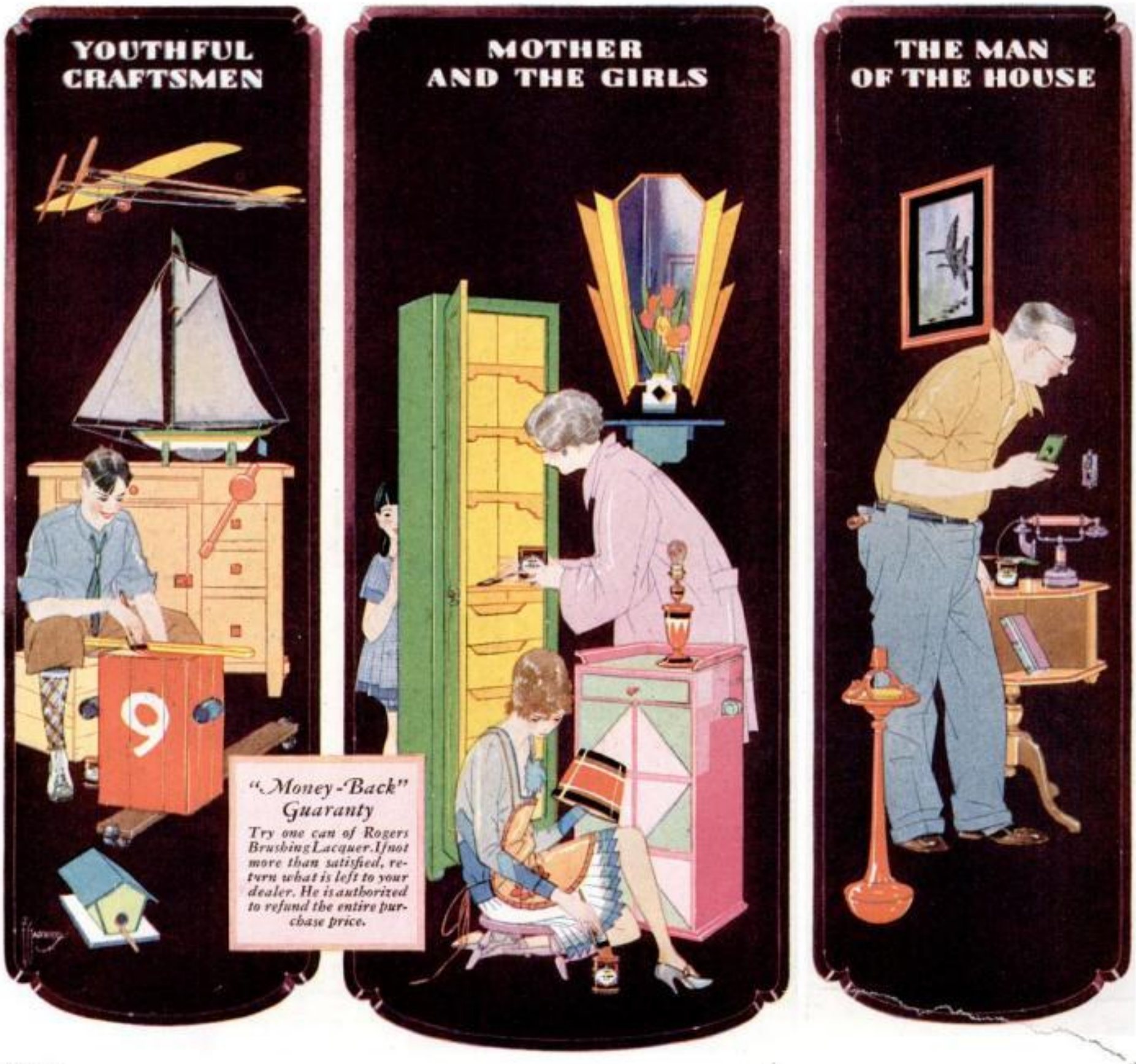

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BOYS, too impatient to wait upon slow drying finishes, find "Rogers" ideal for boats, skooters, wagons and many other things.

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Dries to a tough, porcelain-like hardness that wears and *wears* and WEARS.

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THE MARK OF QUALITY

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Genuine "Rogers" is sold by the leading paint, hardware and department stores everywhere, in the familiar "oriental" container illustrated to the left. Every can is sold on our "money-back" guaranty.

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Where Best to Buy

A GOOD USED CAR

Your Cadillac-La Salle dealer occupies the most advantageous position in the buying and selling of Used Cars—as well as New Cars

THE used car market, generally speaking, offers many excellent values.

Only a few simple and common-sense considerations are needed to guide the buyer in this field.

The first of these is the position and standing of the dealer from whom the used car is to be purchased and the line of new cars he handles.

It is obvious that if his new cars are the recognized leaders in their price division he has a considerable advantage over his so-called competitors.

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This, as is well known, is the fortunate position of all Cadillac-La Salle dealers. It is generally recognized that if you want the kind of performance, the measure of safety and ease and the inimitable beauty that Cadillac and La Salle offer, you must buy a Cadillac or La Salle. They are the accepted leaders of the finest of fine cars.

Consequently the used cars these dealers offer are fairly priced and the stocks are large and varied.

You may be assured that these cars are well conditioned and represent exceptional values because every Cadillac-La Salle dealer is eager to retain your good will.

CADILLAC MOTOR CAR COMPANY

Division of General Motors Corporation

Detroit, Michigan **Oshawa, Canada**

WHAT IS NEW THIS MONTH

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April, 1929, Vol. 114, No. 4. **Popular Science Monthly** is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Copyright, 1929, by the Popular Science Publishing Co., Inc. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3. The contents of this magazine must not be reprinted without permission. In presenting in its editorial columns numerous stories of new products of applied science, **Popular Science Monthly** does not underwrite the business methods of the individuals or concerns producing them. The use of **Popular Science Monthly** articles for stock-selling schemes is never authorized. O. B. Capen, President and Treasurer; R. C. Wilson, Vice-President; A. L. Cole, Secretary.

Financial Racketeers

By WALLACE AMES, *Financial Editor*

I—BROADWAY

DALE HATCH was lonesome. A tough day in the big city and dinner alone left him in no mood to take interest in the movies or the theatres of Times Square. His mail from home only made him feel more lonesome. He went down to the hotel lobby and *just sat* . . . looking the picture of loneliness.

When a companionable sort of chap sitting near-by asked for a light it was no trick to get conversation started. And while Dale was talking about the loneliness of a big city another individual found a pretext to join the group. He had a big-city grouch too . . . he had been over-charged, short-changed and stung by gambling devices and he bewailed the heartlessness of New York. Recounting some of his experiences in a Southern drawl, he revealed the fact that he was an easy mark. Which gave the companionable chap a lofty idea.

"This sap is primed and ready for some confidence man," whispered Dale's newly made friend, while the Southern gentleman momentarily left them alone. "Let's do him a good turn . . . give him a demonstration of how easily he can be roped in . . . then explain the stunt to him, give him back his money and maybe in that way he will learn not to be such easy meat for racketeers.

"We'll match coins, you always playing heads and I tails, so our Southern friend will always lose to one of us."

First they matched for a dollar, then five, then ten. Dale and the companionable chap won alternately. Each time the Southerner got more excited . . . insisting that his luck would turn, and continually raising the stakes, to twenty-five, fifty and finally to a hundred. It so happened that the companionable chap won all the big plays and as he did not exhibit any hurry to reveal the secret, drive home the lesson and return the money, Dale finally took it upon himself to "spill the beans."

Up in the air went the hot-blooded Southerner. "You're just a couple of dirty crooks!" he bellowed out. "And you think you can get away with that, right here on Broadway! I'll show you guys." Dale's explanation didn't seem to register at all. The Southerner was fiery mad, full of threats and all touched off to start a young riot.

A man who spoke as though he were a detective stepped up and inquired the cause of the excitement. While the Southerner was explaining, the companionable chap dove into a taxi and was soon lost in the traffic. The Southerner gave chase, evidently to recover his money. Dumfounded by the turn of affairs and considerably over-awed by the threatening manner of the "detective," Dale Hatch didn't know what to do. Finally Dale was told to beat it and was advised not to get caught again violating the state laws against gambling.

Dale Hatch lost his expense money and had to draw on his firm for more. When he returned home and explained the circumstances to his sales manager he had to stand for a lot of ridiculing. Of course the sales manager, Robert Hayes, would himself never fall for such a sucker trick. Take it from him, he wouldn't. Let's see just how shrewd he really was.

II—WALL STREET

Robert Hayes was getting ahead nicely. From a substantial income he was able to lay aside about $150 a month—nearly $2,000 a year. About the time Dale Hatch returned from his trip, Hayes received a call from a representative of a "big" New York bond house. Hayes had never heard of the firm, but it must be big . . . one or two former United States Government officials were members . . . and furthermore, the representatives sought to interest Hayes only in the highest grade of investments. When Hayes showed an interest in something speculative the representative talked him out of it and persuaded him to open an account to buy some government bonds and other gilt-edge securities, paying $500 down and $150 a month.

Every month Hayes received letters and printed literature, reporting on the status of his securities, reviewing economic conditions, analyzing sound investment opportunities, which added to his general grasp of security matters, and inspired his confidence in his firm of investment bankers. Hayes kept up his payments regularly; his wealth grew steadily; in a little over a year he had nearly completed payments on three bonds.

Along about this time the literature from his bankers began to mention investment opportunities of another character. Interspersed between the reviews of gilt-edge bonds were suggestions regarding stocks, in companies Hayes had never heard of, but which, according to the bankers, were destined to make their shareholders rich. Big earnings . . . big dividends . . . chances for a big rise in the value of the shares.

Just before Hayes completed payment on his three high grade bonds the security representative paid him another call. This time he was all "het up" over a brand new industry just being organized to convert waste corn-stalks into motor fuel. Now, as a matter of fact, some 3,000 useful articles can be made of corn-stalks and corn-cobs.

The door to Hayes' office was open while he was conferring with the bond salesman. Let's listen to the sales talk.

"You know, Mr. Hayes, that our firm only deals in the highest type of investments. We *(Continued on page 5)*

Financial Racketeers

(Continued from page 4)

will not let any of our customers speculate. You know yourself that I got you to put your money in the best bonds on the market. It is true that they only pay you a little less than 5%, but your principal is safe. Still, in these times 5% isn't much income. And once in a long while we get one of those rare chances to help our customers make a bigger income and still be *absolutely* safe.

"Think of the millions of automobiles . . . think of the high price of gas . . . think of the hundreds of millions of tons of corn-stalks going to waste every year . . . picture Corn Fuel Industries, Inc. with its grinding plants dotting the entire corn belt, its pipe-lines and refineries and filling stations all over the United States."

Then, out of the portfolio came charts and statistics of every description, showing how original Standard Oil stockholders were made fabulously rich, picturing possibilities of all sorts to stagger Hayes' imagination.

"That's all very interesting," admitted Robert Hayes, "but I am still tied up paying for my bonds; I haven't the money now, to go into this new deal, although from what you tell me about it I would like to."

"Maybe we can help you raise some cash," suggested the resourceful bond man. "There is a ready market for your bonds. And you have a little profit in them, too. Suppose we sell your bonds and put that money into Corn Fuel Industries Common. Then, instead of less than $150 a year interest on your $3,000 investment, you will be getting $450 a year in dividends . . . and in less than a few months your stock should be worth several times what you now pay for it."

The deal was closed. And soon Robert Hayes discovered that he was just as big a sucker as Dale Hatch. Hatch fell prey to a Broadway Racketeer; Hayes succumbed to the craft of a Wall Street Racketeer.

How nicely this Wall Street racket was worked out. The alleged investment banking firm first won Hayes' confidence. They advised him to buy high grade securities. They worked on him until they convinced him that they were a conservative, reliable house. They helped him to accumulate a considerable sum of money while winning his confidence. By selling him some perfectly good bonds, on which they made no profit, they put him into highly marketable securities, which could immediately be converted into cash when they were ready to make the "kill." So the gilt-edge bonds not only helped to build confidence, but put the equivalent of cash within reach of the crooks when they got ready to reach out their hands for it.

* * *

The above anecdote is based on an actual form of fake security selling that was practiced for a long time by several firms. Hundreds of thousands, perhaps millions of dollars were lost by investors originally tempted (Continued on page 6)

ADVICE IN BUILDING

Popular Science Institute Tells How to Cut 30% Off Your Fuel Bill by Insulating

An insulated house is warm in winter, cool in summer and costs one-quarter to one-third less to heat than a similar house without insulation.

Before you build or modernize your present home, you will want to have full information on insulation. A 24-page booklet, INSULATION IN BUILDING CONSTRUCTION, gives actual facts and figures as to what insulation will accomplish, tells where it is of greatest value, describes the principal insulating materials and shows particular methods of application.

The Engineers of The Institute have prepared this booklet which contains data secured from thousands of architects and builders, as well as university laboratories and Government bureaus. Price 25 cents. Popular Science Institute, 248 Fourth Ave., New York, N. Y.

Financial Racketeers

(Continued from page 5)

by the opportunity to buy sound securities on the monthly payment plan. It is only one of innumerable schemes that are continually being promoted—schemes that come within the law, or nearly within the law—but which end up in loss to innocent people.

There is one law, or principle, which will protect any investor against financial loss through crookedness. That is to invest only with firms or banks of established reputation. Robert Hayes thought his firm had an established reputation—it had as far as he was concerned. But it was established on the thinnest veneer imaginable.

It is easy to find out about a legitimate firm. If you do not know them yourself, and if your banker does not know about them it is easy to get their history. There are firms in Wall Street who make it a business to investigate every security selling enterprise. They gather all the facts about new companies.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

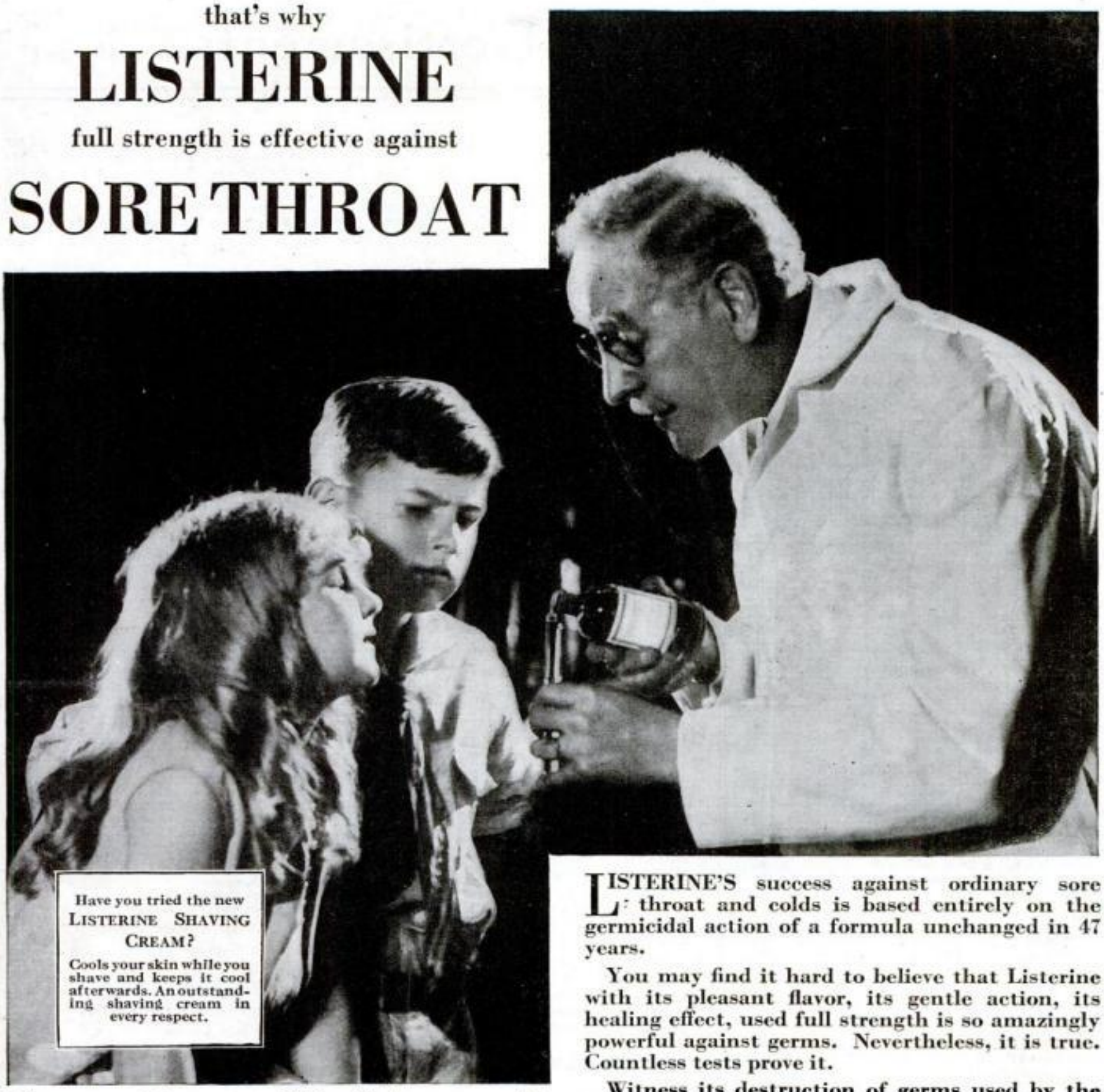
200,000,000 germs die in 15 seconds

that's why

LISTERINE

full strength is effective against

SORE THROAT



Have you tried the new LISTERINE SHAVING CREAM?

Cools your skin while you shave and keeps it cool afterwards. An outstanding shaving cream in every respect.

Prevent a cold this way?

Certainly!

Millions of ordinary colds start when germs carried by the hands to the mouth on food attack the mucous membrane. Being very delicate it allows germs foothold where they develop quickly unless steps are taken to render them harmless.

You can accomplish this by rinsing your hands with Listerine, as many physicians do, before each meal. Listerine, as shown above, is powerful against germs.

Use only a little Listerine

for this purpose—and let it dry on the hands. This simple act may spare you a nasty siege with a mean cold.

It is particularly important that mothers preparing food for children remember this precaution.

LISTERINE'S success against ordinary sore throat and colds is based entirely on the germicidal action of a formula unchanged in 47 years.

You may find it hard to believe that Listerine with its pleasant flavor, its gentle action, its healing effect, used full strength is so amazingly powerful against germs. Nevertheless, it is true. Countless tests prove it.

Witness its destruction of germs used by the United States Government to test antiseptics.

The stubborn B. Typhosus (typhoid) germ, for example. Listerine, full strength, destroys 200,000,000 of them in 15 seconds. Think of it. And the obnoxious M. Aureus (pus) germ is rendered harmless in the same time.

Recognizing Listerine's power against germs, you can readily understand why it checks colds and sore throat which are caused by germs.

At the first sign of either, gargle with Listerine full strength. Keep this treatment up. Remember it is safe to use this way in any body cavity. You will be delighted to find how quickly you get relief. In case you do not, consult your physician, as your trouble may be a symptom of a more deep-seated disease requiring expert attention. Lambert Pharmacal Co., St. Louis, Missouri.

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Guaranteed Advertisements

Popular Science GUARANTEE

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

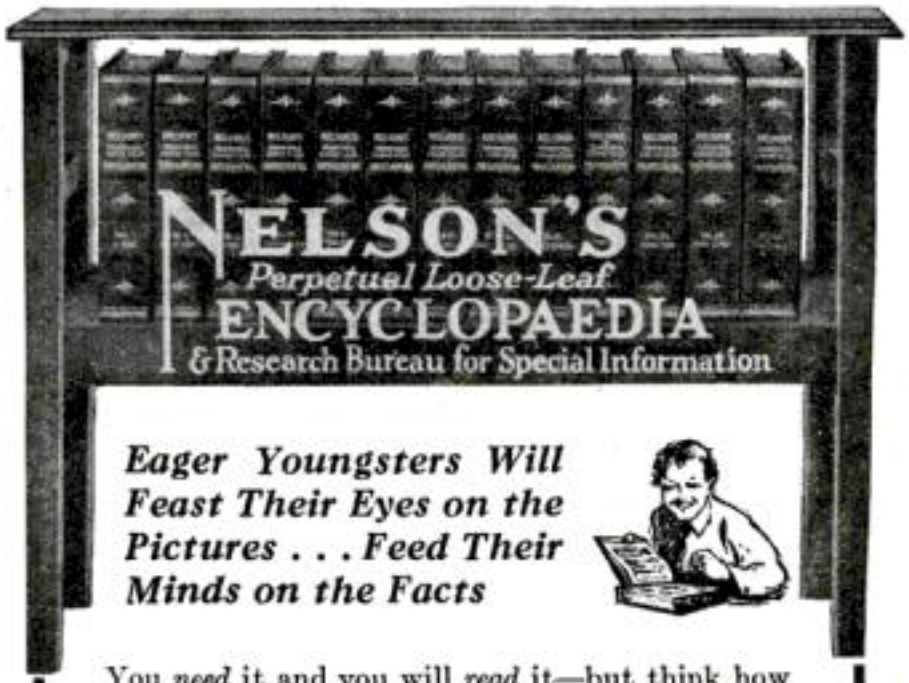
Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

However, other products advertised in the magazine not subject to test carry the same guarantee to readers as products tested.

THE PUBLISHERS

Muscles work for little pay Brains get the Fortunes!

Charles P. Steinmetz came here a poor boy and rose by steady application to be called the "wizard" of electricity, and to command whatever income he might name. Henry Ford—plain mechanic at the start—studied and struggled with his problem till *knowledge* made him master and millionaire. Edison tapped his meagre pay out of a telegrapher's key—but hunger for knowledge and skill in applying it carried him on to astounding heights. These were simple, homely boys whose careers beckon us on to greater effort. At the head of many great industries all over the nation are many men who started with hammers in their hands, and steadily climbed the heights to fame and fortune.



Eager Youngsters Will Feast Their Eyes on the Pictures . . . Feed Their Minds on the Facts

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(1 PASSENGER — — 6 PILOTS)

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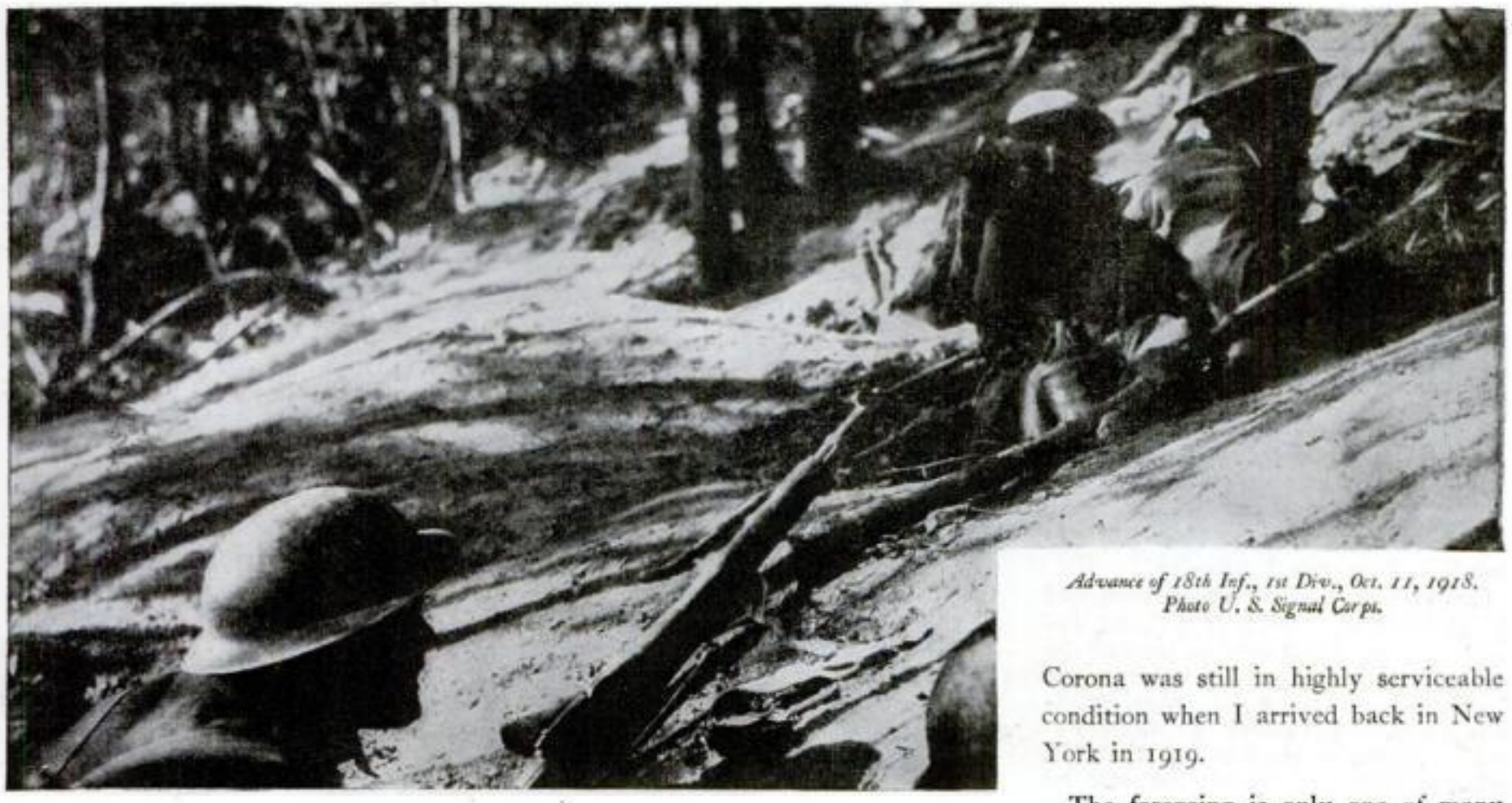

Advance of 18th Inf., 1st Div., Oct. 11, 1918. Photo U. S. Signal Corps.

The story of a typewriter that went to war

By a War Correspondent

IT was in July, 1916. The commander of the British Flying Headquarters at Saint-Omer took me for a flight over the lines.

Holding my Corona between my knees I wrote the first description of the front ever typed from the air. During a cruise in a British submarine I typed a complete magazine story while we were nosing about off Heligoland, a hundred feet beneath the surface. A description of the first Zeppelin raid over London I typed at a shattered window by the light of the fires from incendiary bombs.

Throughout my entire period at the front, all my writing was done on my Corona. Because of its portability and dependability, I made it a constant companion. Many a story banged off hot in a front-line dugout would never have been written if I had waited to reach a spot of greater convenience.

During my war-time work in Europe I typed an average of 15,000 words a week. In addition to this I typed the manuscript of four books. Yet, in spite of a number of emergency repairs made necessary by violent accidents, my Corona was still in highly serviceable condition when I arrived back in New York in 1919.

The foregoing is only one of many astonishing Corona stories. You owe it to yourself to drop into a store where typewriters are sold and see why Corona is the Champion Portable. The minute you lay eyes on it you will realize why a million people use it—why Roosevelt took one to Africa—why 30,000 Coronas were used in the World War—why more novelists, more newspaper men, more business men, more students in schools and colleges use Corona than all other portables put together.

For a small down payment you can take a beautiful new Corona home with you today. Don't neglect this opportunity. Don't let another day pass without doing something about it. Know *now* the joy of owning a sturdy, speedy, smooth-operating Corona—the Champion Portable Typewriter of the World.

An interesting illustrated booklet called "Corona Typewriters," which describes Corona in detail and contains beautiful illustrations of the new color models, will be sent you upon request. No obligation. Simply mail the coupon below.

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6. POPULARITY: *As many Coronas have been sold as all other portables combined.*
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Refrigerator or Germ-Breeder?

By

F. G. PRYOR, SECRETARY

Popular Science Institute of Standards

IN MANY homes a refrigerator does duty until it gets too small for family requirements, fails to fit satisfactorily into a new home, or is about ready to fall apart. Almost never is a refrigerator replaced for sanitary reasons, and yet the essential and important thing wrong with most refrigerators is that they do not refrigerate and are not safe containers for perishable foods.

This consideration of appearance and forgetfulness of health is wrong. Inefficient refrigeration may be poisoning a family slowly, yet nothing will be done about it until the box gets crowded or kitchen appearance is marred by its shabbiness. Then the chances are that the new "refrigerator" purchased will be bigger and brighter but not much more efficient than the old when it comes to properly preserving food.

Food kept at a temperature above 50° F. soon decays, though it may be palatable for some time. Bacteria will multiply 130 times, for instance, in a piece of meat kept forty-eight hours at a temperature of 60° F. In large numbers bacteria are often dangerous though not evident. A test was made with five persons who were all served veal soup in which bacteria had multiplied 1,420 times; the soup tasted all right to every one of them.

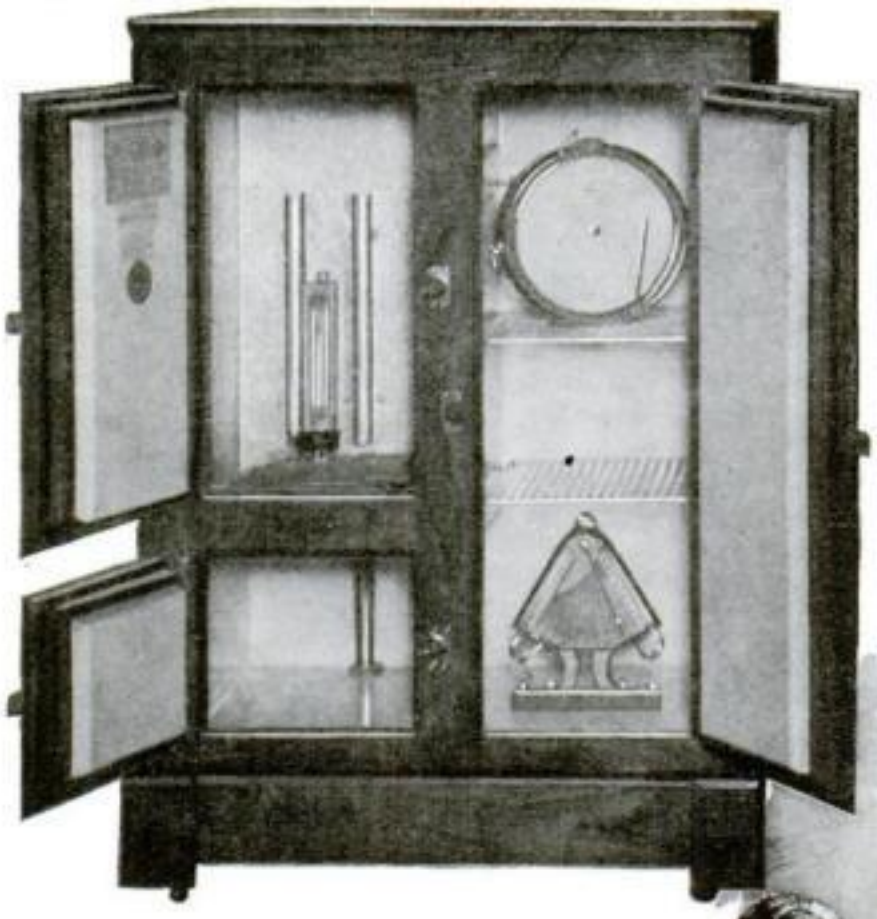
SURPRISINGLY few refrigerators in general use *do* maintain a temperature of 50° or under—in fact, it is a common occurrence to find refrigerator temperatures more nearly approaching the mark set for room comfort than for proper food preservation. The way to determine whether food is being kept safely is to place an ordinary house thermometer in the refrigerator for thirty minutes.

If the refrigerator is a good one, the temperature will not be higher than 50° F. in any part of the food chamber. Should the temperature exceed that safety limit, the box should be replaced. It is false economy to go on using a leaky cabinet that runs up uselessly high ice bills and spoils food, besides endangering family health.

When it comes to selecting a new refrigerator, something more than lining and trimmings should be considered. Food can be kept safely in a refrigerator of either automatic or ice type providing the particular make selected is efficient. So far as cost goes, it is generally necessary to spend more than has been customary in buying cabinets that never really did refrigerate. However, price is not necessarily a means for measuring merit; Popular Science Institute recently refused to approve a fine-looking $150 refrigerator that was found by test to be poorly constructed and most extravagant in ice consumption.

In buying an automatic refrigerator, particularly if one of the widely sold makes is selected, there is not as much chance of going wrong. The manufacturers have had to be careful to use well-insulated and generally well constructed boxes, for a poorly insulated automatic refrigerator would be costly to run since the automatic controls are set for a certain temperature and a great waste of current would occur in keeping the temperature of a leaky box up to the set point. However, an efficient refrigerating unit installed in a properly constructed box requires little electric or gas energy and the operating cost is low.

Entirely different conditions are encountered with refrigerators of the ice type. In the first place, no amount of ice will keep a leaky box at the correct temperature; the heat leaks in faster than the melting ice can cool it, even though a tremendous amount of ice is melted. And consumer demand in the case of refrigerators of the ice type is unusual. Unlike the buyer of an automatic refrigerator, the purchaser of an ice box is not at all concerned about operating cost; what he wants is a good-looking box whose initial cost is low.



A refrigerator that failed to pass the tests. Many so-called refrigerators are not safe containers for food.

When selecting a new refrigerator, it pays to consider more than the trimmings.

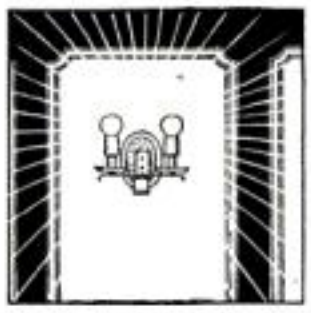
Manufacturers must comply with the demand, and the best concerns are obliged to include at least one line of cheap boxes. A well constructed and insulated box which will properly refrigerate cannot be built under present conditions for the small amount most buyers are willing to pay. Cost must be cut, however, if the refrigerators are to sell; and the skimping is done where it affects appearance least but efficiency most, since buyers are all-concerned with the first and care not at all about the latter.

IN BUYING a refrigerator, therefore, one should be prepared first of all to pay enough to get real refrigeration. If the buyer can afford to buy convenience with good refrigeration, he will do well to select an automatic refrigerator. A survey recently made by an impartial organization showed ninety-five percent of the owners of automatic refrigerators to be entirely satisfied. If a refrigerator of the ice type is selected, special inquiries should be made as to the amount of insulation—two inches of corkboard or its equivalent is essential. No matter which type is decided upon make certain that a real refrigerator replaces the old bacteria incubator.

IN TESTING refrigerators in its laboratory at New York University, Popular Science Institute has found many good makes. A list of these may be obtained free on request. A booklet containing a full discussion of the advantages of various types of refrigerators, together with data on operating cost, precautions in installing, and complete advice on care and upkeep, is available. This 24-page manual, *Refrigeration in the Home*, costs 25 cents a copy. For the list of approved refrigerators and the booklet, address Popular Science Institute, 250 Fourth Ave., New York, N. Y.

Down like lead went display room costs because of this *grainless* wood

Here is a manufacturer whose sales shot up and whose costs went down when he paneled his showroom with Masonite Presdwood. Scores of others have used this sturdy material to solve a shipping problem, improve a product or cut production costs. You, too, may find, in some phase of your business, an ideal use for Presdwood. A generous free sample will be sent on request.



FOR LIGHTING FIXTURE DISPLAY PANELS

The problem of properly displaying their lighting fixtures was a "thorn in the flesh" with Victor S. Pearlman and Company of Chicago, until their architect, Bert C. Hubbard, recommended a showroom paneled in Masonite Presdwood.

Previously, fixtures were screwed to ordinary plastered walls. Changed displays left unsightly marks on the plaster. Screw holes had to be patched. And frequent redecorating was necessary. Now all the walls are paneled in Presdwood.

A different style of fixture is displayed in each section of the wall. The soft brown tone of the grainless wood panels harmonizes with the walnut finish of the rest of the room and sets off each fixture display to best sales advantage.

Presdwood saves decorating cost because it requires neither a rubbed or varnished finish. Although only one-eighth inch thick, this dense, sturdy material holds fixtures weighing up to forty-five pounds, even when ordinary wood screws are used. Old screw holes in Presdwood are easily filled. And when any section shows too many holes it can be removed and a new panel sawed out and put in its place at trivial expense.

Better products—Lower costs

But the uses of Presdwood are not confined to display room walls nor to any one industry, for in a multitude of manufactured products it is making things better while it makes them for less.

FOR RADIO SPEAKER TENSION BOARDS

It is used in radio cabinets, tension boards for loudspeakers, show cases, table tops, portable billiard tables, book cases, kitchen cabinets, china closets and for toys and playhouses.

It makes sturdy shipping boxes with ample strength to protect delicate articles. And it makes smooth boxes with no splintering surfaces to damage sheer silks or the finest fabrics. Because of its resistance to moisture, it is used for dairy product containers, for outdoor signs that are exposed to the weather and for side panels of motor truck bodies that must stand up under the hardest usage.

Liked by production men

Presdwood is easily worked, for it contains no foreign binding material to dull good tools. It is made in four foot by twelve foot boards, either one-eighth inch or three-sixteenths inch thick. It can be punched, die-cut, milled or sawed. And because it lends itself so readily to quantity production methods, it is becoming as popular with the factory production manager as with the sales executive who specifies it for display rooms.

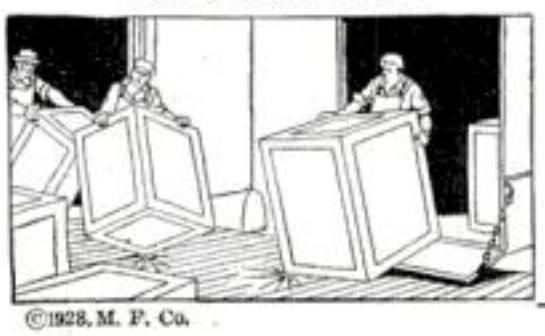
Give Presdwood a trial. It may solve a display or production problem for you as it has for others. A large free sample is yours for the asking.

MASONITE CORPORATION

Sales Offices: Dept. 724 111 W. Washington St.
Chicago, Illinois

Mills: Laurel, Mississippi

FOR STURDY BOXES



Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION

FOR PORTABLE BILLIARD TABLES

Our Readers Say—

What's Wrong Here?

"YOU'VE heard the mythical story of the man who consented to work for one cent the first day and double his wages each day, and how there would not be enough money in the world to pay him? Well, did you ever apply the same idea to count your grandfathers? So far as we know everyone has had two grandfathers (and two grandmothers). Each of your grandfathers, in turn, had two grandfathers, which would be your great-great-grandfathers. Each of them, in turn, had two grandfathers, which would be your great-great-great-great-grandfathers. And so on. I have just been figuring the thing out, multiplying each set of grandfathers by two, as follows:

You	0
Your Grandfathers	2
Your Great-Grandfathers	4
Your Great-Great-Grandfathers	8
Your Great-Great-Great-Great-Grandfathers	16
And so on	32
	64
	128

"The pyramiding figures become appalling. I have carried out the multiplication only thirty-seven times—which, figuring each generation at thirty years, will put us back in time about 1,110 years—and the resulting number is 269,999,730,948 grandfathers! I am sure this number of people never lived on earth at once. History tells us that 6,660 years ago there were comparatively few people. Yet if you figure out the number of your grandfathers who lived 6,660 years ago, you get a figure with sixty-six units! And suppose you should go back 25,000 years—you wouldn't have enough space in this book to write the answer.

"In reality there must have been a starting point when there were only one or two people on earth. But no—we are going the other way. The whole thing is topsy-turvy. Yet there are the figures. I am frank to say I can't answer the puzzle. What's your solution?"—W. E. C., Kansas City, Mo.

Good Target Practice, Too

"I READ with interest the proposal of Prof. William B. Franklin, physicist of the Massachusetts Institute of Technology, for the use of 'smoke rings' to prevent hurricanes. My suggestion of a possible means of limiting the destructive effects of a tornado would be the rapid-fire bombing of it before it reaches cities or towns in its path. This might be done with heavy shell firing, and at least partly break up the force of the 'twister.' I should like to hear what others think of this proposal."—W. G. B., Stratton, Neb.

An Idea, Mr. Guggenheim

"IN THE article 'If You Had Millions to Spend,' the overcoming of sleet was listed by Harry F. Guggenheim as one of four fundamental flying problems remaining to be solved. I believe I have a practical method of preventing sleet forming on an airplane's wings. The idea is to construct all-metal wings so that hot exhaust gases from the plane's motors could be carried through pipes into the hollow wing interior, passing out through an opening at the rear of the wing tip. In flight, the air rushing around the wing tip would create a partial vacuum which would suck out the exhaust gases and prevent back pressure."—R. S. D., Lima, O.

Page Jonah

"JUST a word of criticism of your short article entitled, 'If Brain Size Counted, the Whale Would Be Smart.' That is not a new argument. I read about it years ago. I don't think anyone has ever contended that the *absolute* size of the brain determined the intelligence. It is a fact that man's brain is *relatively* larger and heavier than that of any other creature and absolutely larger than most of them. Furthermore, the advanced races of mankind have larger brains than the inferior races. Great men have large brains."—R. C. C., Jasper, Ala.

Try This on the Fourth

"I HAVE a younger brother who is greatly interested in building and flying model planes such as are published in your magazine from month to month. During a recent conversation I jokingly told him to try and develop a plane propelled by a rocket, my idea having been derived from the recent German experiments. Great was my surprise to find in POPULAR SCIENCE a picture showing German children flying planes whose motive power is furnished by the propelling force of rockets. Here is a problem for Danner Bunch and his collaborator Koch. I feel confident that if there is any merit in the idea they could produce such a model. Let's hear from them!"—E. W. B., Allentown, Pa.

It's Easy to Build

"CONGRATULATIONS on your 'modernistic' furniture. It is a boon to one who is not very good at making elaborate furniture, and is just what I want. I have made your bookcase, and am now making the modernistic lamp. I have been reading your magazine for some time, and it is far superior to any other magazine I have yet seen."—H. R. W., Kingsland, Shrewsbury, England.

No Hoodoo Day for Him

"THAT idea, outlined in your editorial, of changing the calendar so that every month will begin on the same day of the week, strikes me as a good one. But I think it would be wiser to start each month and week on Monday instead of Sunday. Then the thirteenth of the month will always fall on a Saturday instead of on a Friday."—C. G. P., Garfield, N. J.

Canada Calling

"I NOTICE an item in POPULAR SCIENCE which states that 'the recent acquirement of additional lines in Kansas and Texas is said to have made the Santa Fe the world's longest railroad, slightly exceeding its nearest mileage rival, the Southern Pacific System, which has 13,165 miles of track.' May I remind you that the Canadian National Railways have a total of approximately 22,970 miles of track, with the Canadian Pacific following a close second with about 20,000."—J. H. M., Halifax, N. S.

Was It a Bargain?

"IN A recent issue was a description and drawing contributed by one of your subscribers for making and installing a dust layer or sprinkler in the ash pit of a heater. I had a plumber install one of these in my heater. The cost of the installation was $10. I would not do without it for 100 times its cost. For many years I have been experimenting with some method of dampening the ashes. The description and drawing referred to seemed to be the most practical and simple of anything I have ever seen. This one item is worth many years' subscriptions."—W. W. C., Washington, D. C.

Such Ignorance!

"I REGRET to inform you that you have a very poor artist. The one I am knocking is the fellow that drew that picture showing a radio enthusiast's cellar, the one illustrating 'Making a Television Disk.' The drawing was all right, but the artist put cobwebs, etc., all over the radio loudspeaker and other accessories on the shelf. No radio bug patient enough to experiment with television leaves a set lie in one place (or together) long enough to accumulate spider webs. And, by the way, aluminum doesn't crack as the disk on the floor appeared to be."—W. L., Paterson, N. J.

A Use for Them at Last!

"BEADING on a loom is an ancient art. To people taking up this fascinating work it will be found a great help to appeal to the cross-word puzzle for designs."—Le R. O., Ogden, Utah.

Easy to Take

"YOUR index is so divided as to make search of an article delightfully easy."—T. S. J., Tulsa., Okla.

"Your cover is original and distinctively artistic, and the inside is meaty. I am getting wonderful value for my money."—J. W. F., Glasgow, Scotland.

"I find only one objection to your magazine—it's so dog-goned interesting I can't lay it aside till finished."—W. D. S., Orlando, Fla.

Never the same job twice

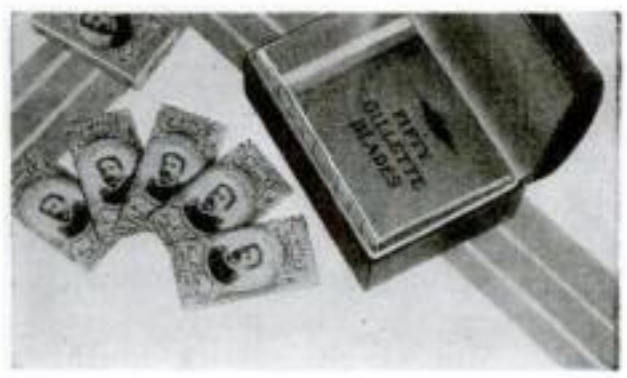
Yes, it's the same man shaving on ten different mornings; ten different conditions of water, temperature, and nerves; ten different methods of lathering and stroking.

But his Gillette Blade meets all these changing conditions with the same even temper

So much dependable shaving comfort has been honed and stropped into this blade that eight out of ten American men have learned to expect—and get—a comfortable shave even under the worst possible conditions.

To meet that expectation Gillette has developed and perfected some $12,000,000 worth of new machines during the past ten years. They condition the Gillette Blade far more delicately and precisely than even the most skilful artisan could sharpen a shaving edge.

Conditions vary. But the Gillette Blade is the one *constant* factor in your daily shave. Gillette Safe Razor Co., Boston, U. S. A.



The New Fifty-Box. Fifty fresh double-edged Gillette Blades (10 packets of fives) in a colorful, useful gift chest. Five dollars at your dealer's.

★ Gillette ★

Gillette

"Buyers seem to be getting modern; guess I'd better get modern too!"

Modern home buyers demand *the extra comforts and economies of Celotex*

SENSIBLE people no longer submit to old-fashioned, heat-leaking construction. How foolish, they say, to put thousands of dollars into uncomfortable, fuel-wasting houses.

They know that Celotex both insulates and builds, stopping heat 3 times as effectively as wood, 8 times plaster-board, 12 times brick and 25 times concrete.

At little or no extra cost, it replaces wood as sheathing, making a stronger wall. Used also as plaster-base, it replaces lath of all kinds and makes finer, smoother plastered surfaces. And as an interior finish, Celotex offers new beauty in its attractive natural tan color and fibre texture.

When such a useful material also shuts out winter chill, dampness and summer heat, protects health and saves 25% or more on fuel bills, *why not demand Celotex insulation?*

The proof is that Celotex has been used in more than 250,000 homes as well as thousands of refrigerator cars and household refrigerators.

Celotex is a superior product—the only insulation made from the long, tough fibres of cane. It comes in big, strong boards, 4 feet wide, 7 to 12 feet long and 7/16 inch thick. These boards add structural strength to buildings. They withstand all kinds of weather—make houses more permanent.

Celotex Lath is 18 inches by 48 inches and 7/16 inch thick. It is especially designed to reinforce against plaster cracks and eliminate lath marks.

These products are also used for insulating roofs in old houses; for lining basements, attics and garages; for making comfortable extra rooms out of waste spaces.

Ask your contractor, builder or architect for further information on Celotex—and send in the coupon below for our free booklet.

The Celotex Company, Chicago, Ill. In Canada: Alexander Murray & Co., Ltd., Montreal. Sales distributors throughout the world. All reliable dealers can supply Celotex Building Board and Celotex Lath.

THE CELOTEX COMPANY
645 N. Michigan Ave., Chicago, Illinois

Please send me free your illustrated booklet, "Year 'Round Comfort and Fuel Saving for Every Home."

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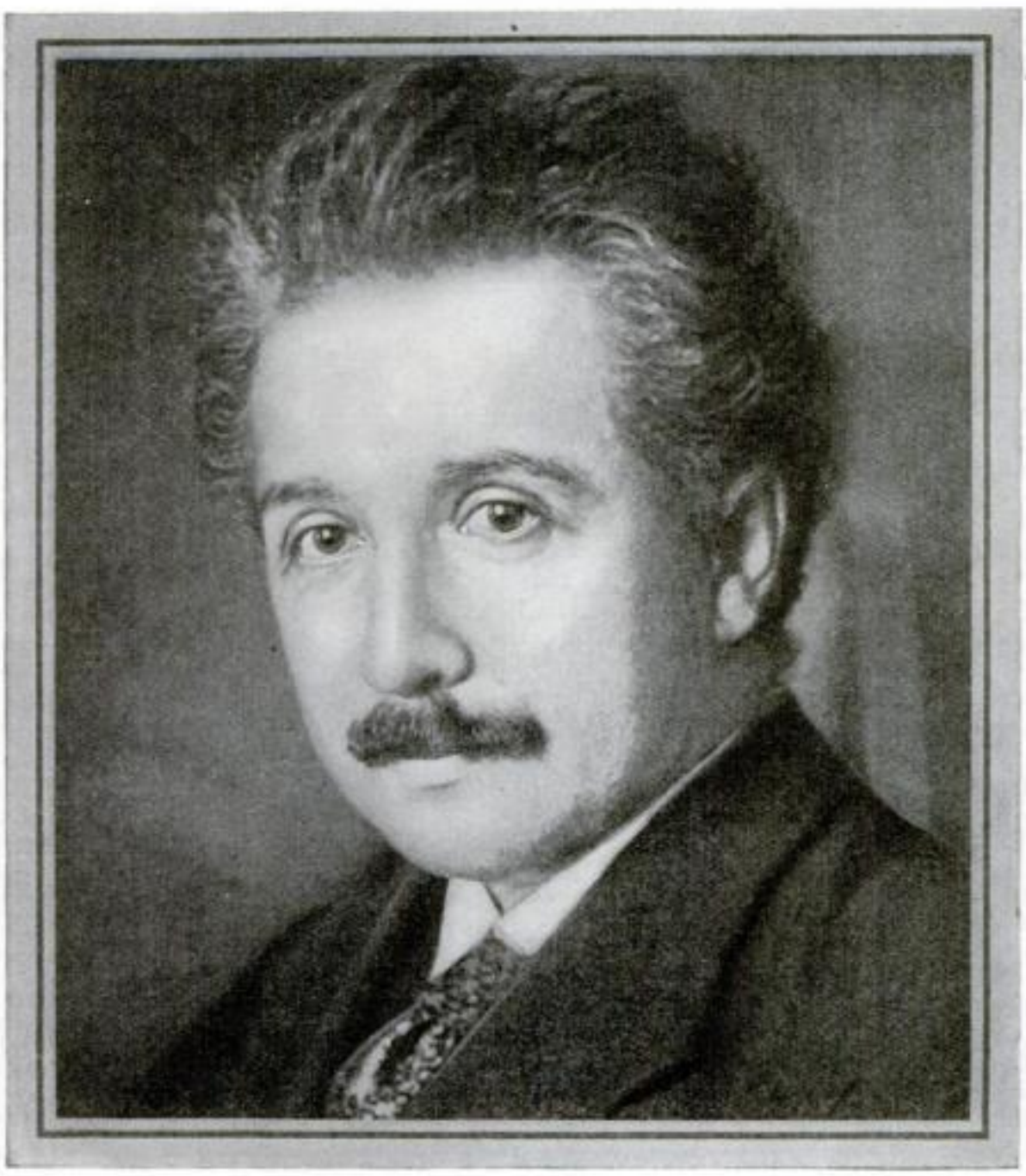
When you buy a house, look for the Celotex sign. It is your assurance of greater home comfort.

Popular Science
MONTHLY

APRIL, 1929 SUMNER BLOSSOM *Editor* VOL. 114, NO. 4



Prof. Albert Einstein. His theory of relativity, which has been called the greatest single achievement of the human mind, has been extended, by his latest discoveries into a single new law of the universe.

Einstein's Topsy-Turvy World

By ALDEN P. ARMAGNAC

OUTSIDE the little printing office in the Prussian Academy of Science building in Berlin, on a Wednesday afternoon, a young man waited his turn to pay one mark for a little pamphlet to be published that day. He scowled at his watch; he had been there since early morning. The clock struck two. A bundle of papers appeared, and was ripped open. The young man's eager hand grasped a little six-page leaflet bearing the cryptic legend "*Zur Einheitlichen Feldtheorie*—Albert Einstein." He raced away, bound for a radio office.

Working hurriedly with photographic paper and solutions, a corps of experts made a photostatic copy and slapped it on a revolving cylinder. The next instant, black and white dots and letters were appearing on a sheet of paper in London. Almost before the Londoner's machine had stopped revolving, he had his copy of the radio-forwarded picture back on a transmitting cylinder. A second later "the biggest piece of scientific news" since Isaac Newton turned some pretty philosophy, about a falling apple, into workable laws of gravity, was speeding to New York at the rate of 186,000 miles a second.

The "news" consisted of twenty mathematical formulæ which Prof. Albert Einstein—author of the "relativity" theory of time and space that attracted wide attention a few years ago—says are the basic traffic laws of the universe. Briefly, Einstein, a mild-mannered little man with bushy hair and a shy, reserved manner, has apparently accomplished what science's leaders have been trying to do for years.

He has justified the exceedingly simple idea, despite its enormously complicated mathematical proof, that behind the "gravity" that endows a piledriver with its mighty blow, and the "electricity" that makes a motor whir, lies the same basic force—an all-pervading one which he terms, simply, "the field." If his theories stand the test of trial, they may

What makes the balls swing out when the shaft is spinning (left), and fall together when it stops (right)? Engineers say "centrifugal force" for the first, and "gravity" for the second. But Einstein says they are the same.

have revolutionary consequences; perhaps even being the basis of new inventions as startling as the radio or the flying machine.

Yet the average man looking at the six-page book entitled "On a Unified Field Theory" would be bewildered at the mass of mathematical hieroglyphics. He need not feel ashamed, for learned professors of science and mathematics confess themselves equally muddled. In the opinion of one of Professor Einstein's colleagues—Prof. Freundlich, head of the Einstein Institute of Potsdam—only a dozen men in the world, today, are able fully to comprehend the new theory.

IT TOOK Prof. Einstein ten years to write his latest six-page book—a little more than half a page a year. It contains symbols that many skilled students of higher mathematics have never seen. To describe the complicated behavior of electricity and gravity, Einstein availed himself of strange characters only recently invented by Herr Weitzenbock, another great mathematician. He even invented a whole system of geometry all his own.

Despite its technicalities, the book recently placed on sale at about twenty-four cents a copy is a "best seller," to a degree unparalleled in scientific literature. Hopelessly swamped with orders, the overworked printing shop of the Prussian Academy of Sciences reflects the amazing interest of laymen as well as scientists in its disclosures.

The linking of electricity and gravity was the one step needed to extend the famous Einstein theory of relativity to account for all the happenings in the universe. So fraught with significance is the newest discovery that it is almost impossible even for Einstein himself to say, hastily, where it will lead.

New and better tubes for your radio are apparently one possibility. X-rays of unheard-of power are another. We may do things with radium that we never did before—mastering, incidentally, in new ways artificial light and radiant heat. These are reasonable guesses, made by men of science, about a few immediate consequences.

However, no man living today can foresee in detail the far-reaching possibilities of the theory. Scientists contrast Einstein's newest manuscript with the theories produced from a London cellar in 1831 by Michael Faraday, a British pharmacist's clerk. Neither Faraday himself nor any of his colleagues dreamed then that these theories would result in the dynamo and the electrical wonders of the twentieth century. Another analogy is that of James Clerk Maxwell, the Scottish physicist who between 1870 and 1879 published a series of mathematical equations proving that light is made up of electrical vibrations. He little realized, any more than did the German physicist Heinrich Hertz, who ten years later, first applied the equations practically, that they would pave the way to radio and television.

Since the publication of the new manuscript, newspapers throughout the world have published thousands of words about it. Einstein had discovered that electricity and gravity are the same, they said. Suggestions were made that since we already know how to insulate against electric currents we might now insulate against gravity. A professor in an Eastern university gravely remarked that we might even learn how to step out of windows without falling! Others pointed out that we might make airplanes fly without wings, and navigate to other planets, all by means of the marvelous insulator against gravity that might result from the new theory.

But Einstein does not say that electricity and gravity are the same, any more than an Englishman and a Chinaman are the same kind of men, though both have two ears, two eyes, and a nose; both are born, marry, live, and die in pretty much the same way. They are similar, but not the same. In his work Einstein really finds a long-sought connection between gravity and electricity, and his theory explains the fact that there is an insulator for the second but none for the first.

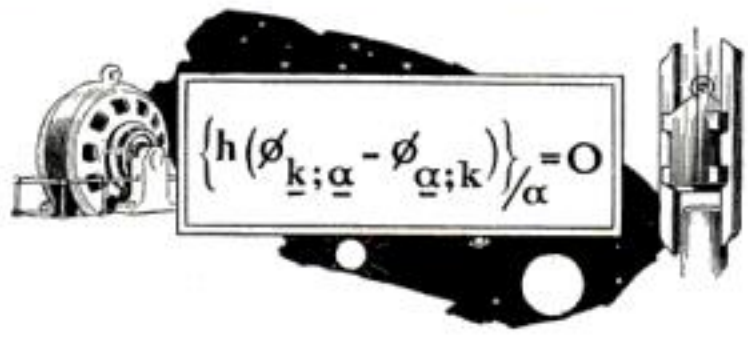
MOST technical men confine their comments to less spectacular predictions. Prof. Thomas H. Gornwall, of Columbia University, says that it is quite probable that we can find as a result of Einstein's new work information as to the nature of light, and that we will be able to account for the behavior of vacuum tubes and radioactivity, to the end that better tubes may be designed. Dr. Charles E. St. John, of the Mount Wilson Observatory staff, in California, sees it as "the first great weapon by which scientists may attack the mysteries of gravitation." Prof. Max von Laue, of the Prussian Academy, says simply that "Einstein will go down in history as one of the greatest scientists of all times, provided his theory is correct."

Meanwhile Einstein himself declines to discuss his newest triumph for fear of seeming to seek self-advertisement.

"I cannot understand why all this noise is being made over my little manuscript," he says. "I do not look for publicity; on the contrary, I do not want it."

The man who caused such world-wide discussion lives with his wife and daughter in a small third-floor flat in Berlin. His study, apart from the living quarters, reeks with tobacco smoke. He likes to play the fiddle—and plays it well, according to his good friend Fritz Kreisler, the great violinist. He enjoys a good movie show, and is frequently seen at Berlin theaters. Anyone who expects to find the author of the relativity and the field theories a cold-blooded, machinelike type of scientist is due for a surprise. He is essentially human.

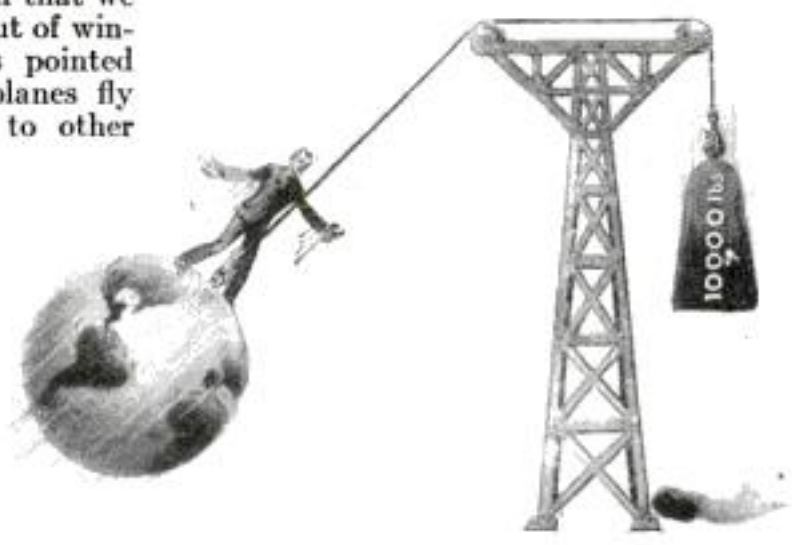
Born of German Jewish parents in 1879, his career of just fifty years is one almost without parallel in the world of science. His original theory of relativity, which attained world-wide prominence ten years



THIS queer combination of letters and symbols is the law of the universe, as expressed in Einstein's new mathematical formula.

Only the world's most brilliant mathematicians are able to comprehend its meaning; yet it explains in one and the same breath the mysterious electricity of the dynamo and the gravity of the pile driver. Even the semicolons between the letters have a complex meaning of their own in an expression of a universal law.

Mr. Armagnac's interesting article is in no wise an attempt at technical explanation; simply an understandable account of what Einstein's latest discovery means to science and to you and me.—The Editor.



Einstein's explanation of gravity and how you can manufacture it yourself. The man will stick to the speeding ball, representing the earth, as long as the falling weight accelerates it fast enough. In other words, the ball pushes up on his feet and holds him to it.

ago, and won him a Nobel prize in physics in 1921, has been called the greatest single achievement of the human mind. It was set forth in its essentials in a "book" of three pages. According to a bibliography compiled not long ago by Prof. Morris Lecot, of the University of Louvain, no less than 3,775 books have been written to explain it!

WHEN the Royal Society of London gave its approval to this remarkable theory, in November, 1919, it burst practically unannounced upon the world. Such matters as whether space is curved, whether there is a mysterious fourth dimension, immediately became topics of parlor conversation. Only a few college professors remembered that away back in 1905 Einstein, then a young man of twenty-seven, had told all about his theory, in a little paper contributed to the *Annalen der Physik*. It had taken fifteen years for it to receive the Royal Society's approval.

In the first place, young Einstein had had the temerity to challenge the laws of gravity laid down by Isaac Newton in 1687.

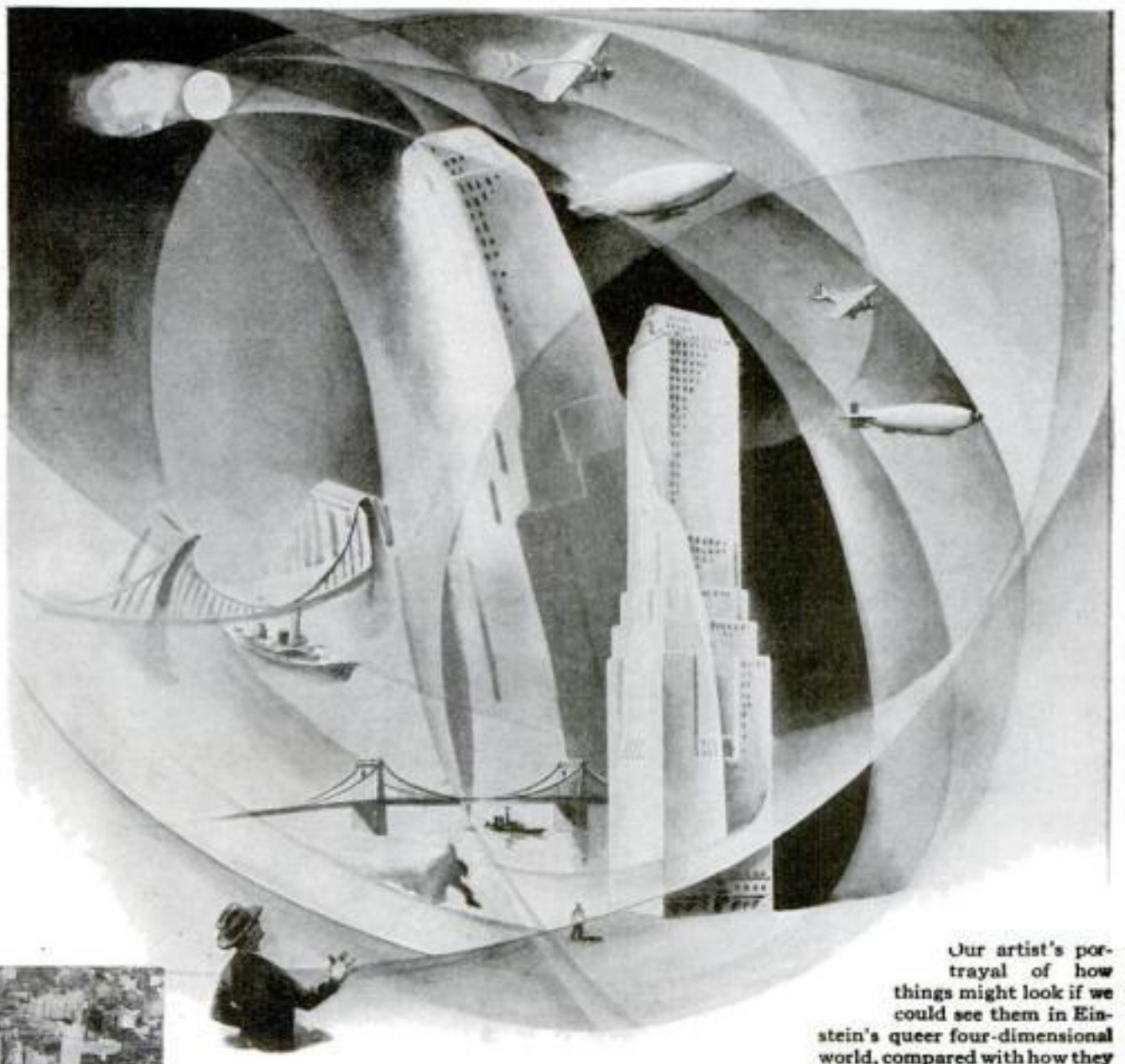
In a view like this, you may think you are looking at skyscrapers, says Prof. Einstein, but actually you see only three-dimensional "shadows" of the real thing.

Newton's laws were good enough for ordinary mortals, Einstein said; but when applied on such gigantic scale as astronomers use, they didn't exactly fit the facts. For illustration, Einstein pointed to the erratic motion of our neighbor planet, Mercury. Every so often it failed to keep an appointment in celestial space that astronomers, figuring its course by Newton's laws, had predicted for it—and showed up somewhere else instead, greatly to their consternation. What Einstein proposed was a new law of gravity, retaining all of Newton's but adding just one slight correction. The new law explained why Mercury wabbled from its course.

But critics claimed Einstein's figures were "padded" to give the right result which, of course, was known in advance in Mercury's case. So Einstein made a bold statement, which delighted them. He prophesied that, in accordance with his new law, starlight would be found to be bent in passing the sun, so that stars near the sun would be shifted in their apparent position a considerable amount. Moreover, Einstein calculated and announced exactly how much they would be shifted. An eclipse of the sun was scheduled to occur on May 29, 1919, at which it would be possible to make exceedingly accurate measurements of stars around the sun.

Two expeditions of British astronomers photographed the eclipse; one from an island on the west coast of Africa, and another at Sobral, in Brazil. When the plates of both expeditions were developed, they showed to the amazement of the astronomers a shifting of the stars that not only confirmed Einstein's theory but almost exactly agreed with his calculated figures.

Then the world heard about Einstein. Columns upon columns, in newspapers and magazines, were used to explain that only seven men—sometimes the figure was set at twelve, or four—could understand the theory. Attempts were made to clarify it for the lay reader. But even 3,775 books, not to mention an ambitious motion picture film replete with diagrams, hardly sufficed to make it all clear. The Relativity Theory, which with the addition of Einstein's latest work becomes an explanation and correlation of everything from space to electricity, is as mind-staggering as ever with its astounding notions. And the controversy among scientists that it started is still raging, though certain parts of the theory are now generally accepted as true.



Our artist's portrayal of how things might look if we could see them in Einstein's queer four-dimensional world, compared with how they appear in three dimensions.

Is there a mysterious fourth dimension, of which Einstein so glibly speaks? We speak of things as having length, breadth and thickness—those are our three ways of measuring. Now Einstein tells us that we have only partly described an object; that time is the fourth dimension. In other words, the time of an object's existence must be stated also if that object is to be described completely. All four "dimensions," he adds, are so closely interwoven that they depend upon each other. He can trace and express in mathematical terms the connection, measured in latitude, longitude, altitude, and time, between such apparently unrelated things as the chair in which you are sitting, the Battle of Waterloo, the moon, and next Tuesday.

EINSTEIN plays hob with geometry as we know it. A straight line is no longer the shortest distance between two points, he says; instead, the shortest way is a curve. All space is warped, and curves back upon itself. If you were to fire yourself, astride a projectile, straight out into space, in a few million years you would return to your starting point. Further, he explains, a fall from a height is not the result of the pull of gravity—but of the earth coming up and hitting the falling object.

Things shrink when they move rapidly, Einstein says. A train speeding at sixty miles an hour is shorter than a train standing still. But a solid six-foot rod shot forward at the speed of *160,000 miles a second* —

(Continued on page 133)

Sh!—They're Filming "Talkies!"

An Actor Tells from His Own Experiences Just What Goes on in the New Sound Studios

By

NORMAN FOSTER

Arrangement of typical talking movie studio, showing apparatus for recording scenes and sounds simultaneously. Note precautions to kill all foreign noises.

I'M IN the "talkies" now!

After five years as a Broadway stage actor, I have begun work in my first talking movie at the Paramount studios near New York City. On my first morning there, I was ushered into a strange and bewildering world where shadows are made audible, words and music photographed; where sights and sounds are printed, canned, and shipped to the four points of the compass! For the first time in years, I suffered stage fright when I stood upon the "stage." When I use this word, you shouldn't imagine the raised platform of the theater. In movie parlance, a "stage" is a large, high-ceilinged room where a "set" has been arranged for a scene to be played and photographed.

It was strangely still here; I heard no voices, no whir of cameras; nothing! I stretched my hand toward a door knob and a burly individual, who had been quietly eyeing me, grabbed my arm.

"Don't move! Stay where you are!" he whispered.

"But," I protested.

"S-h-h! Don't talk! They're 'shooting'!"

For a minute or two I stood where he halted me, gazing at a blank wall and a door. Then we were joined by an assistant director whom I had met before. The latter smiled, but immediately put a finger to his lips to forestall my greeting. The silence was oppressive, uncanny. One scarcely dared to breathe.

Suddenly, a loud, long ring from an electric bell startled me. Instantly, a thousand-and-one noises assailed my ears. The door was flung open with a bang. Everywhere at once, people called to each other, walked about, talked, coughed. Machines hummed. A bedlam of hammering, sawing, planing, and scraping seemed to have broken loose and the blare of a jazz band could be heard through the din.

"One long ring," the assistant director explained, "is the signal that a rehearsal or the actual 'shooting' of a scene has ended and that normal activities may be resumed. When they start rehearsing or filming a scene, the signal is three rings, which means all must be quiet.

"You see, in making 'talkies' we have a double job. Not only must we get sounds into the pictures, but we must also keep out sounds that don't belong there. I never knew how many senseless noises there can be until we began making 'talkies.' Now, let's go in and I'll show you the stage."

I was surprised, even a little disappointed. I had expected to see many intricate and mysterious looking machines and devices, but all that seemed to distinguish the place from an ordinary movie studio were two or three microphones suspended from the ceiling.

"They are condenser microphones, one of the types used in radio broadcasting," said my guide. "They usually hang overhead as the actors talk, just beyond the range of the camera lens. In making 'talkies,' the microphone is of equal importance to the camera. A 'mike' is like a small-town gossip—it hears and repeats everything. That's the reason for the bell signals and the enforced silences."

The monitor, master "organist" of the "talkies." He operates the microphones and controls volume of sound and tone.

I LOOKED around. The "stage" was a room measuring about forty by ninety feet. The particular scene set up in it represented a well-appointed private office.

"Outside of those microphones," I remarked, "I don't see anything out of the ordinary here."

The assistant director smiled.

"There's plenty!" he said. "For example, this room has been made as soundproof as possible by building terra cotta tile walls with air spaces between. The doors are double. Monk's cloth drapes are hung about to deaden echoes and reverberations. Also, the inside of the walls are treated with sound-absorbing material. Now look at the cameras."

I observed that these machines —three of them to "shoot" the scene simultaneously from as many different angles—were inclosed in thick-walled booths, like padded cells.

"What's the idea?" I asked.

"To muffle their grinding, of course."

The booths had three padded walls and a fourth of plate glass

through which the cameras were pointed. These "cells" move on wheels with pneumatic tires.

Next, my friend pointed out that the customary Kleig lights had been replaced by noiseless lamps, also that the floor was covered with thick, gray felt that muffled every step. Even the "office" desks were overlaid with thick felt pads.

"That's to prevent them from acting as sounding boards to the actors' voices," my guide explained. Then, picking up a chair, he added:

"YOU see, each chair leg has felt tacked underneath to deaden sound in case it's moved around."

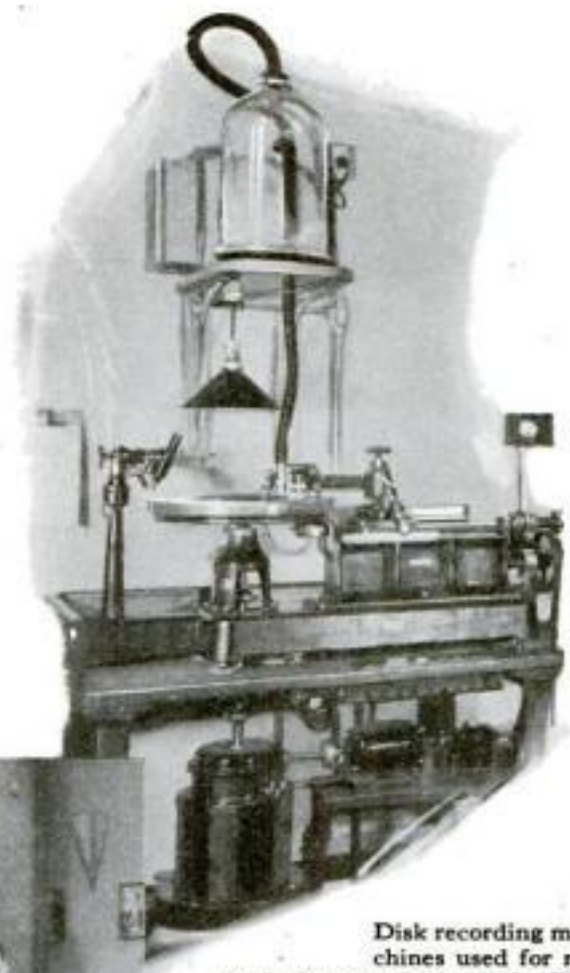
I had noticed, on a mezzanine overlooking the studio lengthwise, two rooms with large windows through which, now and then, I could see men who obviously were surveying the stage.

One of these rooms, the assistant director volunteered, is the "monitor room"; the other the "sound room." Sounds caught by the stage microphones are carried to the monitor room by wire. Here an operator, known as the monitor, uses a potentiometer, a device by which electrical voltage can be varied, to control the volume of sound transmitted. Through a loudspeaker, he hears every word or noise on the stage, and it is his task to regulate sounds to make them natural. From the monitor room, the sound is carried to an amplifier, an instrument similar to the audio amplifier end of your radio set, which increases its strength several thousand times; thence to the sound room, where it is recorded.

By this time, the stage had filled with people.

"Now watch closely," said my guide. "They are going to have a sound rehearsal. You understand, of course, that a scene must sound absolutely right before we can afford to reproduce it in a theater. For that reason, sound recording here is done by two methods—on wax disks like phonograph records, and on film. We use the disk method only for rehearsals. It permits of instant reproduction, which we call the 'play back.' There is another way of making 'talkies' that uses the disk method not only for rehearsals, but also for final recording and screen presentation.

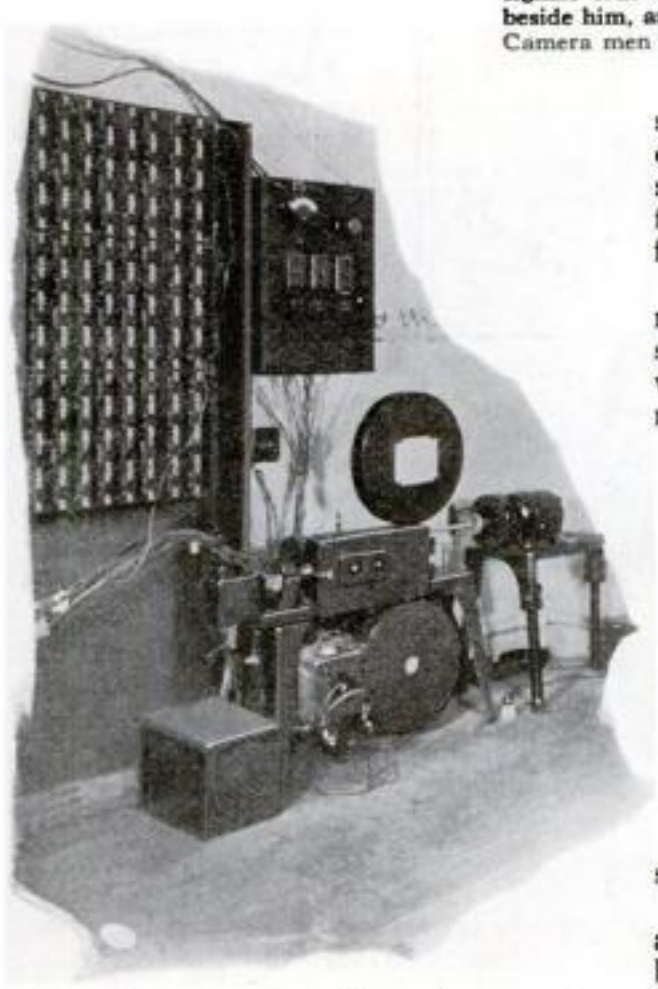
"During the play back, the director, the sound expert in charge of making the 'talkie,' and the actors can criticize the sound values of a scene. Not until everybody concerned feels that the scene sounds just right is it 'shot' for final reproduction. But you will see for yourself."



Disk recording machines used for reproducing sound rehearsals. The disks on turntables receive the sound impression, as in phonograph recording. Glass jars hold wax shavings from record.

"Shooting" a talking movie. The director, seated, signals orders by pressing buttons. The script girl sits beside him, and standing near by are the sound experts. Camera men may be seen behind plate glass windows.

Norman Foster, former Broadway stage actor, who in this article tells what he found behind the scenes in a "talking movie" studio



Recording machine, in which translated sounds are taken as lights and shadows on the film.

The director sat on a camp chair near one of the cameras. Beside him stood the sound expert. I noticed he was in almost constant telephonic communication with the monitor.

The actors took their places.

"Silence!" the director commanded. He pushed a button on a little control box beside his chair to signal the sound department that he was ready. In answer, a green indicator lighted on his box.

"Green light!" he called.

Everybody stopped talking. The recording equipment was adjusted. Then a red flash appeared on the little control box—the signal that the sound department was "all set" for the rehearsal.

The director again pushed a button and three long, loud rings of the electric bell pealed through the plant. The famous three rings!

Everything in the plant stopped dead.

The sound rehearsal was on. The hero sat behind the desk in his office. A young woman entered and, in a short dialogue, gave the man her telephone number. This he jotted down on the corner of a newspaper. Exit young woman. A man entered. During their brief talk the hero tore off the numbered bit of paper and put it in his vest pocket. Exit man caller. End of scene. One bell! All activity and noise was immediately resumed.

"That seemed fine to me," said the director. Then, to the sound expert: "How did it strike you?"

"Sounded O. K. to me."

"Well," said the director, "let's have a play back."

THE sound man phoned to the monitor room; then, with the director and actors, left the stage to take chairs outside. All eyes turned to a huge loudspeaker protruding from the wall beside the monitor room.

A buzz. "Silence, ladies and gentlemen," cautioned the director. "They'll give us the play back on this."

A rasping sound like static over your radio. Then—"Good morning, Mr. Snell." It was the voice of the young woman in the (Continued on page 170)

Planning a 44-Mile Tunnel!

How Engineers, Deep in the Earth, Aim Gigantic Tubes at an Invisible Bull's-Eye and Make Them Hit the Mark

By GEORGE LEE DOWD, JR.

NEARLY a hundred feet below the East River, at Fifty-Third Street, New York City, recently there took place an amazing example of engineering skill. Months before, workmen had started on opposite sides of the river, burrowing toward each other, building a new subway tunnel. When the bores met, the machinery in one passage pushed into the other like a thread entering the eye of a needle. The sixteen-foot openings, after more than a mile of blind, underground digging, met within one fifth of an inch of perfect alignment!

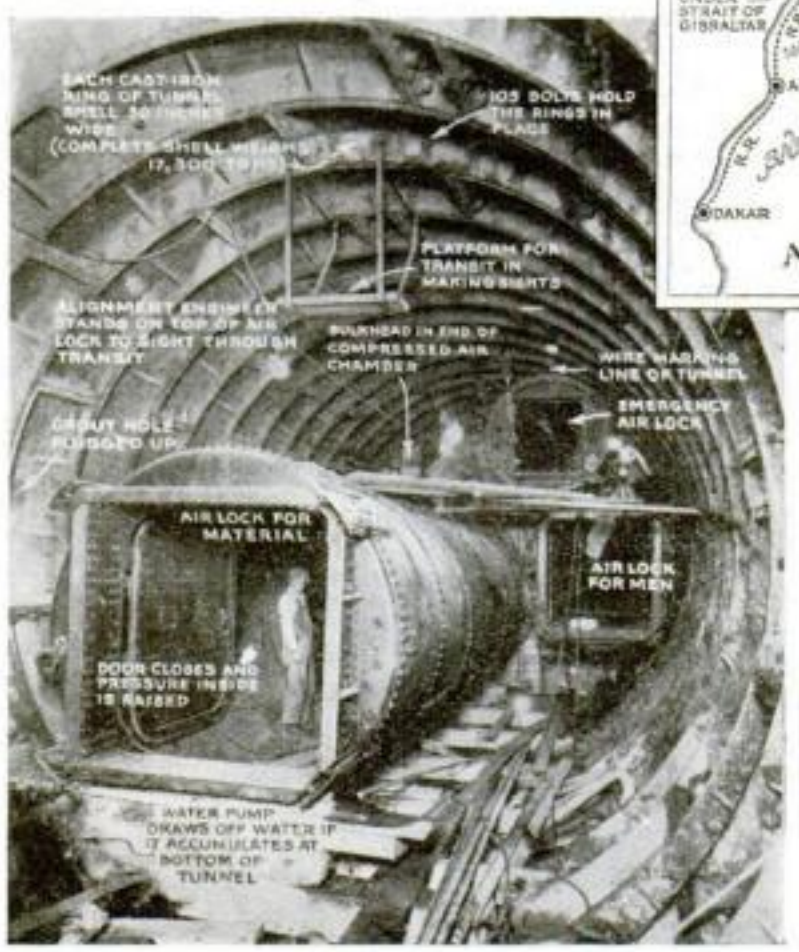
London crowds viewing a model of the proposed 44-mile tunnel under the English channel. The immense tube, which would cost $150,000,000, would link London and Paris by direct railway.

About the same time, in the Cascade Mountains of the State of Washington, a blast "holed through" the two halves of the new Great Northern Railway tunnel, longest on the Western Hemisphere. Gangs, cutting from opposite sides of a mountain, had penetrated nearly eight miles of solid granite. Three thousand feet below the peak the bores met. They missed a perfect joining by only seven inches.

A supreme test of engineering skill in tunnel guidance will be afforded if the often-discussed tube under the English Channel is actually undertaken, as now seems likely. The latest plan calls for a forty-four-mile tunnel, entering the ground eleven miles from the English seacoast near Dover, burrowing through the chalk of the channel bed, and coming up nine miles inland between Calais and Boulogne on the French side. Such a tunnel, costing $150,000,000, would allow a broad gage railway to lead directly from London to Paris. It would be nearly four times as long as the longest tube now in existence, the Simplon Tunnel of the Alps, which is slightly more than twelve miles in length.

A PLOWMAN guides his furrow by driving toward a tree or stake on the other side of the field. A surveyor lays out a line by taking bearings from landmarks on the earth's surface. But a tunnel engineer works deep in the earth, hedged in by narrow walls that confuse the sense of direction, his horizon limited to a few feet. Yet, he dare not get off the line a hairbreadth, for a tiny angle of error, at the end of a mile of digging, may cause the bores to miss each other as cleanly as trains passing on parallel tracks.

Tunnels under English Channel and Strait of Gibraltar would join England with Africa.



Interior of the new transit tube under the East River, New York City, showing the methods of alignment and construction.

Some years ago, in a large city on the Great Lakes, that very thing happened. Inexperienced city engineers started a long water supply tunnel at opposite ends. When they thought the passages were on the point of meeting, they had an expert check the work. He discovered that the two tunnels would miss by 275 feet! The insertion of an "S" curve saved the day.

One of the hardest of the many exacting problems of tunnel construction is "steering" the passage to an unseen point far ahead. How it is accomplished was explained to me by the two men who had most to do with "hitting the bull's-eye" in the latest East River tube. They are S. H. Coombe and W. R. Barry, New York City engineers.

AS THE first step in that job surveyors laid off the course of the tunnel on the surface of the earth, as they would lay off the line of a road. The problem was to transfer this line underground, working at both ends of the tunnel. A shaft, twenty-four feet in diameter, with its opening bisected by the line, was blasted in the rock of each river bank to the depth of the tunnel at that point. Plumb bobs suspended from steel wires were lowered to the bottom of the shaft from positions on the line at each side of the opening. The alignment engineer, taking a position in a cavern hollowed out at the bottom of the shaft behind the landward wire, sighted through his transit telescope until the two wires, like sights on a rifle, were in line. A third wire, directly in line with these two, was established at a point a hundred feet ahead (Continued on page 141)

Capt. George Fried, operating compass that traced the sinking *Florida*.

A Machine That Makes Heroes

How the Radio Compass Found the *Florida* and Defeated Death at Sea

By H. C. DAVIS

Nelson Smith, the *America's* chief radio operator. For sixty-one hours he stood at the compass, tracing the lost vessel.

WHILE a sixty-mile gale lashed the Atlantic into shifting mountainous seas, thirty-two men, 700 miles off the Virginia Capes, clung to the rail of the sinking freighter *Florida*. For days it had drifted with the wind, rudder broken, decks awash, rails coated with ice.

No human being, not even the men on board, knew the vessel's position. The log book and instruments had been swept overboard. The radio operator, Nunzio di Gangi, sending his frantic SOS, was giving a position 150 miles away, the last observed. Two near-by steamers, rushing to answer the call, arrived at the position indicated and found only a waste of tumbling water. They proceeded on their courses. Somewhere, lost on the ocean, was the sinking ship, calling for help.

Three hundred and fifty miles to the north, the liner *America* was buffeting its way toward New York under the command of Captain George Fried, hero of the *Antinoe* rescue three years before. He heard the call and with racing engines turned south. The events that followed, ending in the rescue of all thirty-two men, form an epic of human heroism and skillful navigation that is still fresh in mind. But more than that, they reveal the uncanny ability of a few inches of magic wire—the pointer of a radio compass. Captain Fried proclaimed this instrument the mechanical hero of the rescue. "We found the *Florida*," he said, "solely by use of the radio compass."

The two vessels that were forced to give up the search were not equipped with such compasses. They could only go to the spot indicated in the call for help. But, on the *America*, the silent, infallible finger of wire on the compass pointed to the actual source of the radioed distress signals 150 miles to the northeast of the reported position.

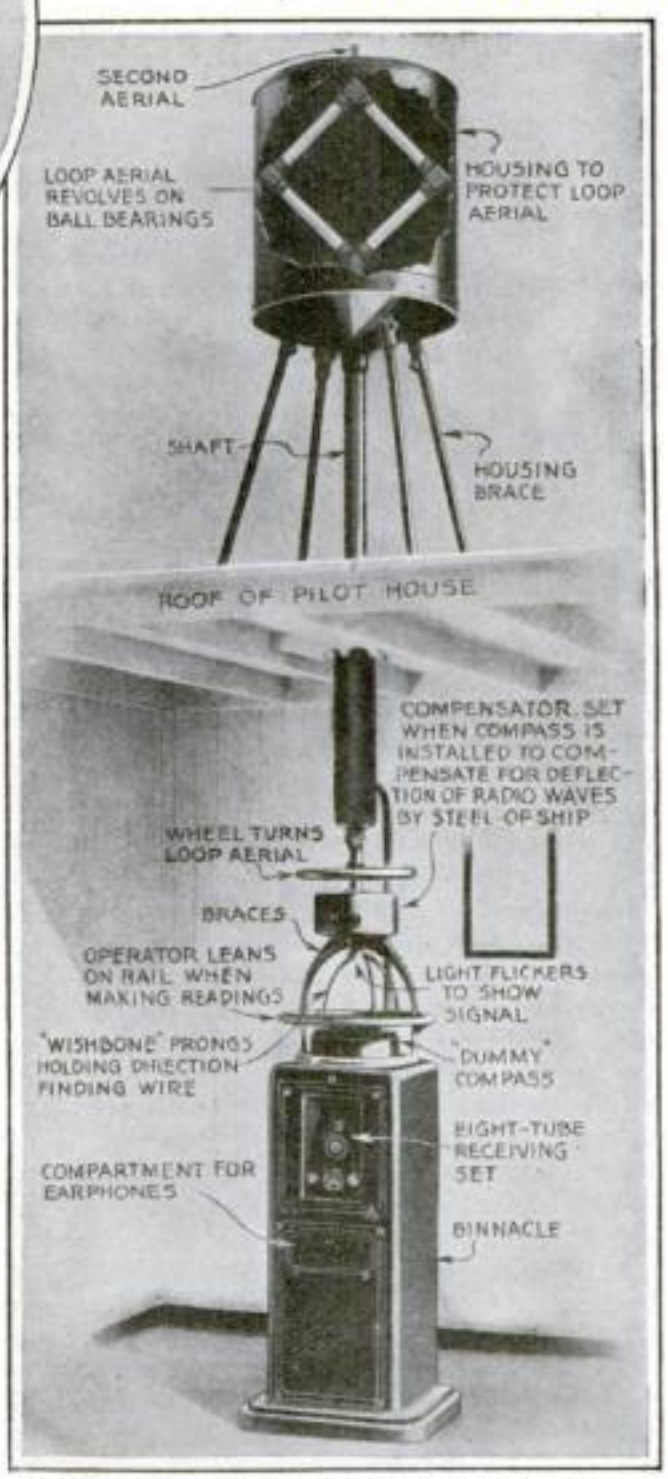
For sixty-one hours the *America's* chief radio operator, Nelson Smith, a veteran of the *Antinoe* rescue, bent over the instrument tracking the *Florida's* weakening signals to their source. Until, guided by the unseen finger of wireless, the liner arrived in time for Chief Officer Harry Manning and eight of the crew to rescue the men of the *Florida* when the life of the foundering vessel appeared a matter of minutes.

Just three years before to the day, a similar instrument had led Captain Fried, then master of the *President Roosevelt*, to the sinking British steamer, the *Antinoe*, which had drifted 100 miles from its reported position. After battling a terrific storm for three days, he saved the crew of twenty-four men.

From the beginning, the radio compass has been associated with saving human life. It was invented during the war, in 1915, by Frederick A. Kolster, American radio pioneer, and used on transport ships to detect enemy submarines by pointing in the direction from which their code signals came.

The operation of the compass is based upon the fact, known to every owner of a loop aerial radio set, that the strength of signals depends upon the position of the aerial in respect to the direction from which the radio waves are being broadcast. When it is edgewise to the direction of the source, the volume is greatest; when the opening of the loop faces the source, the volume is least.

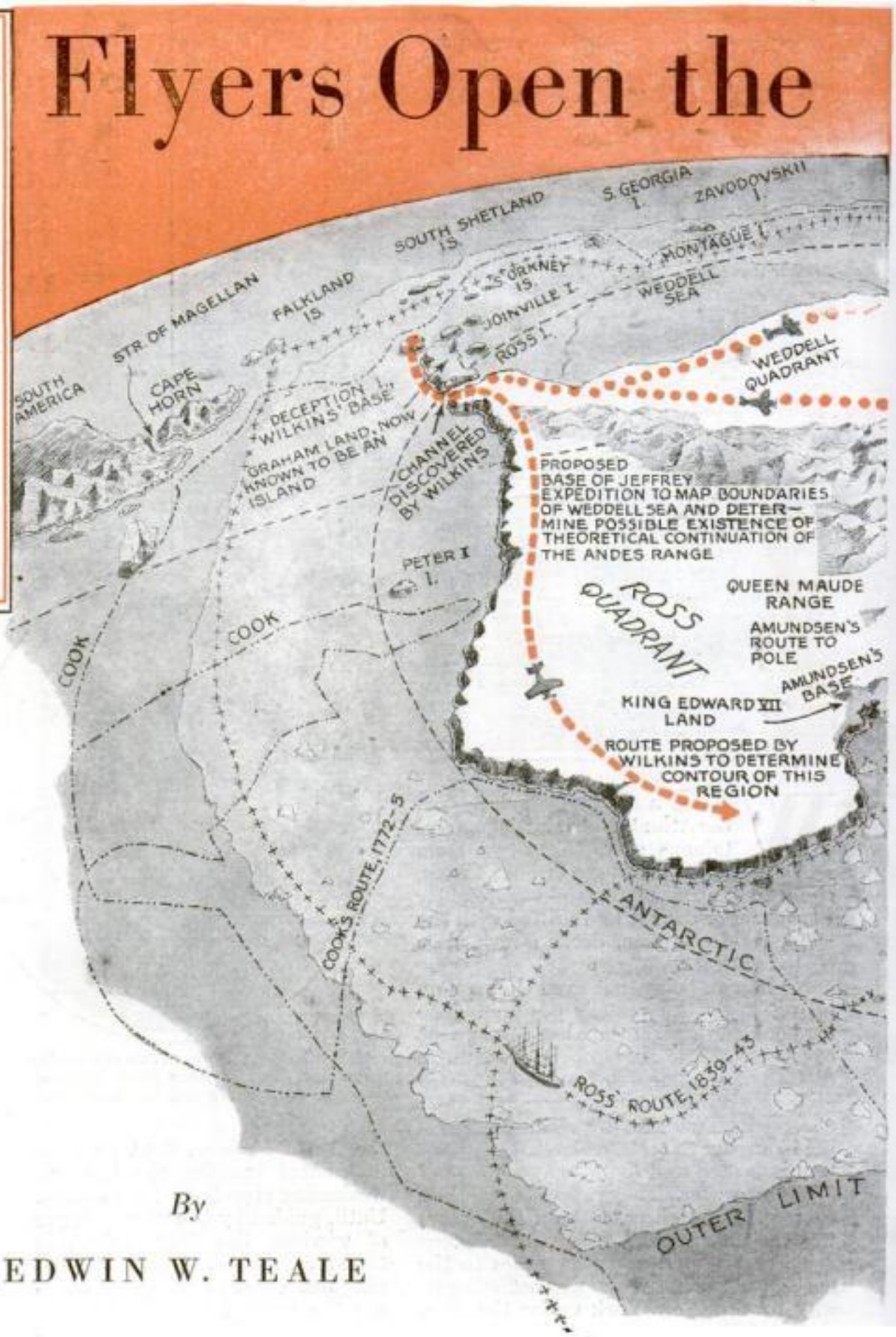
The loop aerial, or receiving coil, of the compass is installed on the roof of the pilot house, protected by an insulated housing, within which the loop revolves on ball bearings. A shaft running down through the pilot house roof connects the loop with the main case of the compass, containing an (*Continued on page 137*)



Design and operation of the radio compass. Direction of signals received on the radio set below is determined by variations in their strength as the loop aerial above the roof of the pilot house is turned.

Flyers Open the

Captain George H. Wilkins. On his first Antarctic flight he discovered Graham Land to be an island, changing map of the world.



By

EDWIN W. TEALE

FLYING into the Antarctic, over territory no one has ever seen before, explorers, with the latest aerial equipment, are heading into a land of mysteries. How much is unknown about the Antarctic and how much can be learned by a single flight over its frozen waste was illustrated recently by Capt. George H. Wilkins, the daring Australian who also flew over the North Pole from Alaska to Spitsbergen in 1928. On his first hop from his Deception Island base, he discovered that Graham Land is not a peninsula attached to the Antarctic Continent, but an island, thus upsetting the ideas of three quarters of a century. Other mysteries of this, the least known part of the earth, undoubtedly will be solved by Commander Richard E. Byrd and his expedition of eighty men, who even now are making flights of discovery into the interior from a base on the Bay of Whales. On his first long flight recently with Pilots Bernt Balchen and Harold June, Byrd viewed and mapped some 10,000 square miles of King Edward VII land, hitherto unexplored. **In a five-hour journey they discovered a new island and fourteen mountain peaks.**

Exploration has barely opened the door of this frozen land lying at the bottom of the world. Four million six hundred thousand square miles of its area, it is estimated, remain a blank spot on the map. Two men have reached the South Pole on foot. Captain Roald Amundsen, the Norwegian, who was lost in the Arctic last year, discovered it on December 14, 1911. The English explorer, Captain Robert F. Scott, arrived on the spot a month later, meeting his death on the return journey. They started from opposite sides of Ross Sea, an indentation in the land directly south of New Zealand. A large portion of the explored area of the continent is bounded by their converging trails. This known area, shaded, is like a narrow slice cut from a huge white cake. The vast unexplored portion is enveloped with ice and with mystery.

One fact concerning the region around the southern pole has been determined. It is the world's mightiest refrigerator. Nowhere else on earth is there so much ice. It covers all the land and reaches out in pack ice beyond the limits of the Antarctic Circle. Imagine one solid piece of ice as large as the United States and Mexico combined!

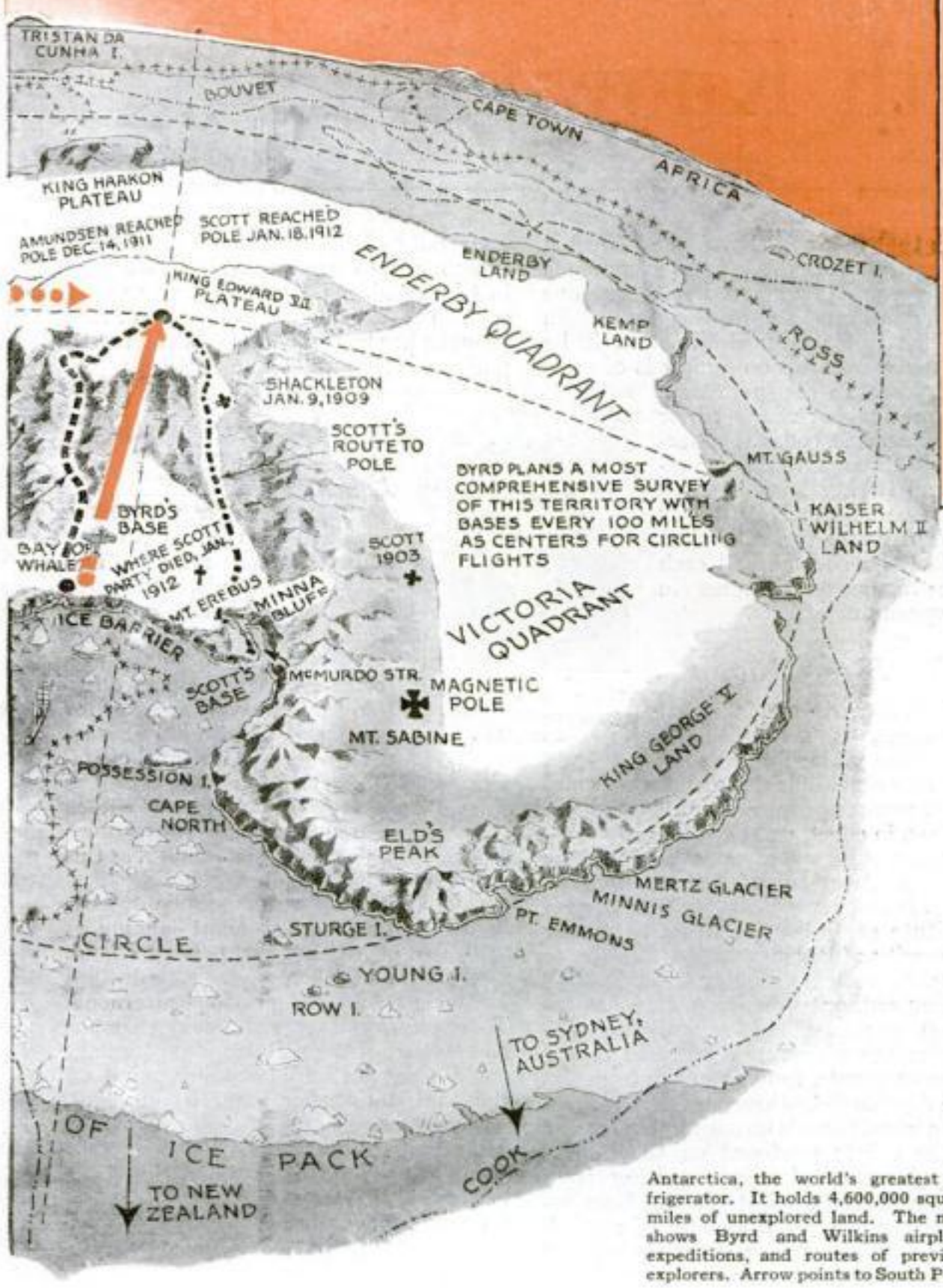
If, like Commander Byrd, you were to approach this relic of the Ice Age, you would penetrate first a belt of huge floating icebergs. Then you would enter a zone of grinding pack ice, covering the sea like a gigantic jig-saw puzzle. When your ship had battered its way through, you would find yourself at the great ice barrier of the Antarctic. Sheer precipices, gleaming white, would tower above you, sometimes 250 feet high. This tremendous wall of ice is believed to encircle practically the entire Antarctic continent. One of the few known breaks in it is at the Bay of Whales, where Commander Byrd has established his permanent base.

You can best understand the topography of the circular continent within this wall by imagining a great white disk wheel. Beyond the ice barrier, the land slopes upward for 400 miles until it reaches a plateau nearly two miles high, standing like the hub of the wheel and containing the South Pole. The diameter of this plateau "hub" is thought to be 800 miles; that of the continent "wheel" from 1,200 to 1,600 miles.

ALL approaches to the Pole have been made from the Ross Sea side. If Byrd's planes, carrying automatic cameras that photograph an eight-mile-wide strip of the territory below, fly over the Pole, as planned at this writing, and circle the plateau beyond, the developed film will answer many questions about the character of this lofty plain.

How will explorers, flying over an end-

World's Ice Box



Antarctica, the world's greatest refrigerator. It holds 4,600,000 square miles of unexplored land. The map shows Byrd and Wilkins airplane expeditions, and routes of previous explorers. Arrow points to South Pole.

Commander Richard E. Byrd. From his base on the Bay of Whales, he is making flights of discovery into regions never seen by men.

less sheet of ice at a hundred miles an hour, know when they reach the Pole? A delicate instrument, known as a bubble sextant, will tell them. This is like an ordinary sextant, such as mariners use to discover their position by determining the angle of the sun above the horizon, except that a bubble level, similar to the common carpenter's level, takes the place of the horizon.

As the plane flies toward the Pole, continual observations will be made with this sextant. Each time the angular altitude of the sun above the horizontal plane is measured, it will be compared with the value the altitude of the sun would have at the instant of observation, if the observer were located at the Pole itself, as stated in the Nautical Almanac published by the U. S. Naval Observatory. By making a succession of measurements of the sun along a single meridian, for all meridians of longitude converge at the South Pole, the navigator will arrive at a point where the altitude he gets on his sextant is that which the Nautical Almanac tells him should be at the Pole. A sextant camera has recently been invented which photographs the sun and automatically keeps a record of the position on the film each time the shutter is snapped. It will enable flying explorers to keep a record of their course and to prove they reached the Pole.

IN THE interior of the Antarctic, science believes there is no life. There is no food in the great refrigerator. During the six months night, the temperature descends to eighty degrees F. below zero, 112 degrees below freezing, and even in the hottest days of summer, when the sun blazes for twenty-four hours a day, it never rises above zero. So, it is thought, no seed can sprout, and where there is no vegetable life, animals cannot exist. Because there is no hunting, the Antarctic contains no Eskimos.

Only on the fringes of this desolate land of gleaming ice and wind-blown snow are there signs of life. Snow pertels and skua gulls appear for a few weeks in summer, living on sea animals. Byrd and his comrades encountered penguins—queer, flightless birds—standing in groups like soldiers at attention on the ice. These birds remain the year around, laying their eggs in the snow. Whales, fish, and seals are found in Ross Sea. One reason the Bay of Whales is most often chosen for a base by explorers is that there seals provide a sure food supply for the dogs.

THE Antarctic is "The Home of the Blizzard." A dead calm may become a shrieking, forty-mile-an-hour gale in two minutes. A clear sky may be filled with blinding, wind-driven snow in the same period of time. This tigerlike pounce with which the Antarctic blizzard descends is duplicated nowhere else. Ninety-mile winds are common and blizzard gusts may reach 150 miles an hour. The average summer temperature at the South Pole is given as nineteen degrees below zero. In winter, it is the coldest spot on earth.

A subtle connection between the climate of the Antarctic and that of half the world is believed to exist. Meteorologists have observed that a severe winter in the South Orkney Islands, near the Antarctic Circle, means a drought three and a half years later in the Argentine wheat belt, while a mild winter results in abundant rains and a fine crop in the South American country after a similar time interval. They also link this reservoir of winds at the bottom of the globe with the monsoons of India and believe it has much to do with the height of the flood waters of the Nile in Egypt. When meteorologists of the Byrd expedition return with data covering months and perhaps years, half the world may know important facts about how its weather is formed. (Continued on page 169)

Robert S. Murray cracks safes for an honest living.

Glimpses *of* People Worth Knowing

Thomas D. Campbell raises wheat by engineering.

RECENTLY newspapers published a story of a "chinless" young man who had been provided with a "strong" face by a bone-grafting operation. A piece of his shin bone had been transplanted to his lower jaw. The patient reported that, soon after the operation, he had obtained a job which he had been unable to get before because of the impression created by his receding chin.

The surgeon who gave the young chap a new face, a new "character," and a new job was Dr. Fred Houdlett Albee, professor of Orthopedic Surgery at the New York Post Graduate Medical School. He is the inventor of a comparatively simple little instrument that has come to be known as "Dr. Albee's bone mill." With its aid, thousands shattered by the World War or injured in accidents have been given new bones for those lost; numberless cripples have been restored to normal and useful lives, and hundreds of hunchbacked children have been made straight, strong, and happy.

In common with other far-reaching inventions, the origin of the Albee bone mill was almost incredibly casual. When the famous surgeon was a boy of ten, living on a farm in Maine, he amused himself one day by making a toy buzz saw out of an old piece of zinc and fitting up a crude turbine to run it by the power of a brook that ran through the fields near his home. The saw would not cut through wood, so the boy used turnips for "lumber."

Dr. Fred Houdlett Albee, repairer of human bones. He has restored hundreds of cripples.

Twenty years later, the pathetic plight of hunchbacked children made Dr. Albee remember the small make-believe sawmill. Medical science already knew there was no better method of bone-grafting than to transplant part of the patient's own skeleton to the affected part of the body. The problem was to find a way to perform these operations quickly enough.

If he could make a machine that would cut through human bone as fast and easily as those zinc saw teeth had slid through the turnips, the trick would be done. Finally Doctor Albee devised a little steel saw, an inch and a quarter in diameter, with tiny teeth, and driven at high speed by electricity. This he fitted with depth gages, to determine the depth of the cut.

That was the beginning of his wonderful new surgical technique. In the fifteen years that followed, Dr. Albee perfected his device and taught its uses to thousands of surgeons. As a result Dr. Albee is one of the busiest men in the world. In addition to his medical school work, he personally operates on hundreds of cases each year. In his spare time he is president of a bank, editor of a magazine, consulting surgeon to three railroad companies and twenty hospitals, and chairman of the New Jersey Rehabilitation Commission. Besides, he goes abroad each year to deliver lectures in European universities.

The Sleep Doctor

BEING tired, even in a good cause, is no legitimate reason for pride; fatigue may be as reprehensible as drunkenness and as dangerous as asphyxiation!

That, in effect, was one of the startling conclusions presented recently before the National Academy of Sciences by Dr. H. M. Johnson, psychologist of the Mellon Institute of Industrial Research of the University of Pittsburgh.

Dr. Johnson is probably this country's leading authority on sleep. He has directed a painstaking investigation involving the observation of some ninety different people, ranging in age from sixteen days to sixty-three years.

He found there is no essential difference in the effects produced on the human body by the poisoning resulting from fatigue, from intoxication, and from asphyxiation. A small amount of alcohol, a little fatigue, and a slight decrease in the supply of oxygen act as stimulants; large quantities of liquor, great fatigue, and a considerable oxygen decrease are mental and moral depressants.

One question asked by thousands, "How much sleep do I need?" he confesses himself unable to answer. That, says Dr. Johnson, is a matter which each individual must settle for himself.

Dr. Johnson declares that he himself can get along with but six and a half hours. Born on a Missouri farm forty-four years ago, his first job was with a railroad construction gang in the swamps of southwest Arkansas. Later he was educated at Missouri Valley College, Johns Hopkins University, and the University of Chicago. He did research work for the General Electric Company in Cleveland, and during the war was a captain in the Sanitary Corps. For four years he has been director of the investigation of sleep at Mellon Institute.

Dr. H. M. Johnson, leading authority on sleep, says "Fatigue is just like intoxication."

Elinor Smith, seventeen-year-old endurance flyer. "I sing as I fly."

A Girl Ace at 17

A SEVENTEEN-year-old girl aviator thrilled the world the other day when she remained in the air thirteen hours, sixteen minutes and forty-five seconds. She was Miss Elinor Smith, a recent high school graduate of Freeport, N. Y. Her plucky performance broke the world's solo endurance record for women at the time, but soon afterward she lost the championship to Miss Evelyn Trout, of Los Angeles, Calif., who flew for seventeen hours, five minutes and thirty-seven seconds. Undaunted, Miss Smith, at this writing, was planning to try again.

Completing her endurance flight, Miss Smith made a perfect night landing at 3:33 A.M. at Mitchel Field, Long Island, where she had taken off in her Bluebird biplane at 2:17 the previous afternoon. To eager questioners she said that she had "sung all the popular jazz songs she could think of" to keep her mind off the cold during her long, frigid flight.

Young as she is, Miss Smith has 425 hours of flying to her credit. She took up flying when she was fourteen, but had to wait two years before she could get a private license.

Fridtjof Nansen, dean of explorers. He's going to the Pole this time in *Graf Zeppelin*.

Last summer she reached an altitude of 11,663 feet. A few months ago the Department of Commerce ordered her not to fly for fifteen days because she had flown under the four East River bridges—a feat never before attempted by a woman.

When not flying or tinkering with her plane, Miss Smith devotes her time to horseback riding and music. She plays the piano and a banjo.

The Dean of Explorers

ALTHOUGH almost sixty-eight—an age at which most men wish to enjoy retirement and comfort—Fridtjof Nansen, (Continued on page 135)

SWITCHING ON *the* SUN!

Valuable Facts About How to Choose and Use the New Health Lamps

By

ROBERT E. MARTIN

Lying on the bed in his own home, this child enjoys an electrical sun bath in the health-giving rays of the newest type of carbon sun lamp. Goggles are worn to protect the eyes.

PRESS a button and turn on the sun. It's that easy. Anyone can have a private sun hitched by a few feet of lamp cord to the nearest convenience outlet.

"Health lamps" now are being offered in many varieties. All have one aim—to supply artificially the healthful rays of sunshine. But the individual who is not getting enough natural sunlight, and who seeks a lamp that will supply it, may well be bewildered at the number and variety offered him. Which is the best? Are they really good, after all? These are questions being asked in every section of the country today.

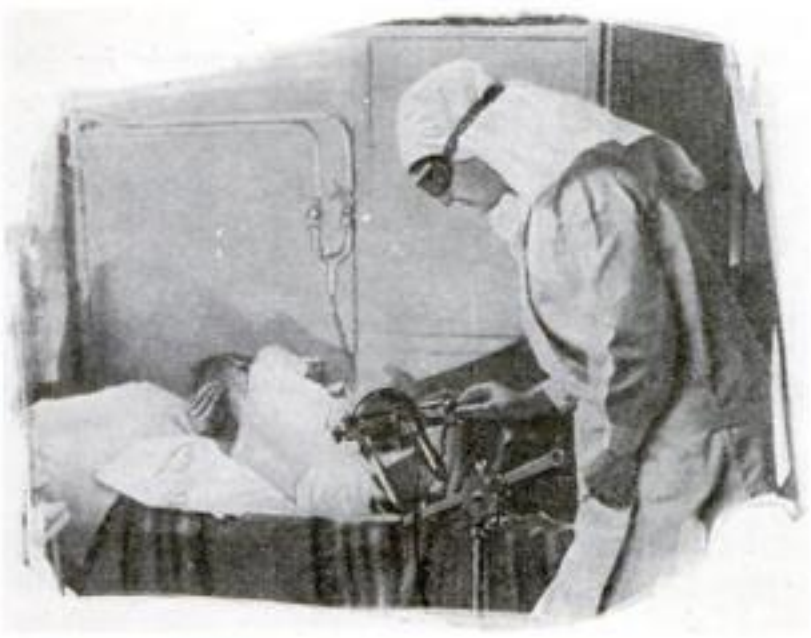
It isn't necessary to point to rickets—a favorite example of the dire effects of darkness—to emphasize the beneficial bodily effect of sunshine and the danger of its lack. According to many authorities a person habitually exposed to sunlight is best fitted to meet extremes of heat and cold. Certain types of tuberculosis are treated by sunshine, natural and artificial. The "ductless glands" of the body, whose secretions are important in shaping our emotions, are now believed to be affected by the sun—which may account for the cheering psychological effect of a bright sunny day. We constantly are finding new curative powers in the rays generated by the sun.

But our present-day civilization keeps many of us out of the sun for most of every day. As a result sunlight lamps have been developed. Good lamps and bad ones have been devised. Some have no more medical value than an ordinary electric light bulb; others produce rays approximating those of the sun. Out of this need for an artificial sun, two principal types of lamps have come. One of these is known as the "mercury vapor" lamp. Its peculiar greenish light, familiar in the studio of any commercial photographer, is a relatively "cold" light. The other type, the "carbon arc," produces its rays from a pair of white-hot carbons, across which plays an electric arc. It is intensely hot. The choice lies between these two. To understand the difference we must first examine the properties of sunlight.

Sunshine looks white—but it isn't. Actually it is a blend of all the colors of the rainbow. You can see these colors when sunlight is split up, as by passing it through a glass prism, to form the rainbowlike color band, violet at one end and red at the other, technically known as the "spectrum".

But sunlight also has in it rays of light invisible to the human eye. One band of these rays, found just outside the red end of the spectrum, is called "infra-red" rays. These are the heating rays of the sun. Another group of invisible rays lies outside the opposite, or violet, end of the spectrum and is termed "ultra-violet". These are the skin-tanning rays.

Mercury vapor lamps, inclosed in quartz tubes, are effective in the production of active ultra-violet rays. To be sure, most "health lamps" produce, or claim to produce, a large amount of these rays. But the mercury vapor lamps, sometimes known as "ultra-violet lamps," have a concentration of energy from the ultra-violet part of the spectrum, making it possible for an individual to obtain in a short time the benfiecial results of ultra-violet light artificially. But caution is necessary. Exposure foolishly prolonged will result in severe burns.



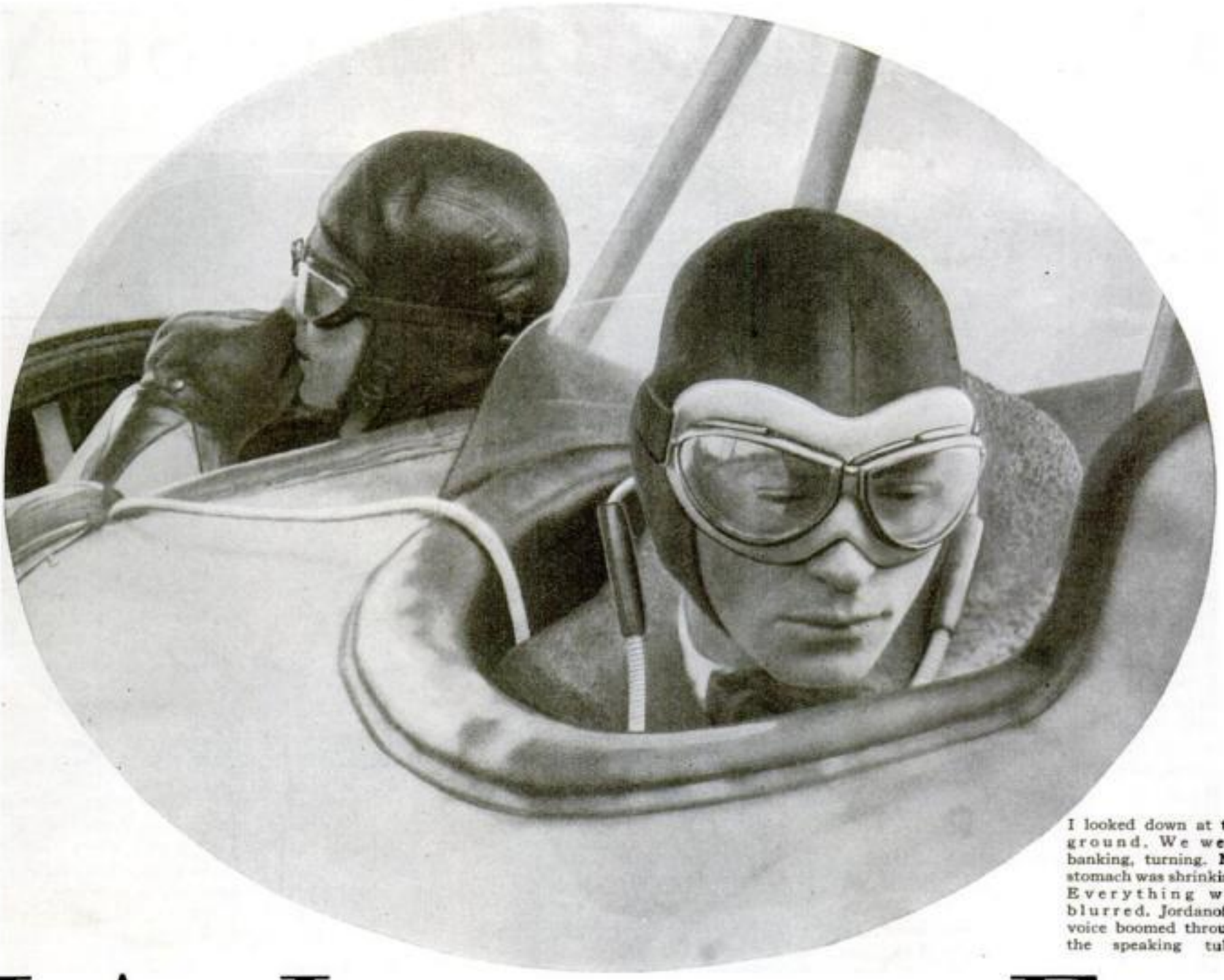
Treating a patient in London Light Clinic with a health lamp similar to that used for King George of England during his illness.

THE "carbon arc" lamp is of entirely different type. Unlike the mercury vapor lamp, it endeavors to approximate all of the rays of natural sunshine. The United States Bureau of Standards recently described it as the nearest approach to natural sunshine. It contains ultra-violet rays in therapeutic quantities, the infra-red rays from the other end of the spectrum, and rays from in between.

Lamps of either of these types, reliably made, may be useful for health treatment. So far the mercury vapor lamp has found perhaps its widest use in hospitals. The carbon arc has been sold widely for household use. With either type, tinted goggles are worn during a sun bath. Before buying a lamp, in any event, it is well to consult a physician as to the exact needs of the individual patient.

Recent improvements and mechanical refinements have resulted in lamps peculiarly suited to use in the home. One of these, for instance, has an automatic shut-off mechanism, operated by a time clock, that makes it possible to use the lamp without fear of over-exposure. In the development of carbons for the arc type of lamps, outstanding improvements have been made, exemplified in a recently-introduced "electric sun." Behind it lies the romantic story of a young man with a leaning toward photography and an insatiable curiosity.

Looking for a lamp with suitable light for night picture-taking, Roy Mott, a young research engineer of Cleveland, O., tried hollowing (Continued on page 139)



I looked down at the ground. We were banking, turning. My stomach was shrinking. Everything was blurred. Jordanoff's voice boomed through the speaking tube.

I Am Learning to Be a Flyer

In the Air at Last!—More of the Stirring Adventures of a Greenhorn Who Is Breaking into Aviation

By LARRY BRENT

A MECHANIC in greasy brown overalls jerked the propeller of the blue biplane. The motor snorted, barked, roared. A blast of brown dust swept back.

In the forward cockpit sat a begoggled instructor. In the after cockpit sat a pale, begoggled young man.

The plane taxied away. A man standing near me laughed and said, "His first lesson," and two other men laughed.

I couldn't even smile. Before long, I, too, would be sitting in an after cockpit. But first I wanted to take things in; get the feel of the place. A little nervous? Maybe. Mostly bewildered. Everything was so strange.

It was my first visit to Curtiss Field, N. Y., since passing the physical examination of which I told last month. The air hummed with the exhaust of unmuffled motors. Planes were everywhere, planes of many kinds, gliding down out of the sky, circling above the field, taxiing over the uneven ground, lying still at the edges of the field or in the rows of great hangars that flanked it. I sat on a low board fence to watch—and get my bearings.

A man of about my age in flying clothes sat down near me and fixed his attention on the sky. Presently he turned and looked at me.

"Student?" he asked.

"On my way to sign up," I answered.

"Ever flown?"

"No." I hated to admit being so green, but he seemed friendly. His name was Gula Owens, although he went by the nicknames of "Bubber" and "Bud." His home was Miami, Florida. He was a student, having saved enough for his course by selling bonds.

"Who are you having for an instructor?" he wanted to know.

"Can I pick my own?"

"Sure! Did you see that tall bird with the black mustache and the aerial camera who breezed by a minute ago? That's Bill Winston—the man who taught Lindbergh. He's flown over 6,000 hours."

"I'll take him," I said promptly.

"You can't. Bill isn't doing regular instruction any more. He's the field manager now—boss of the works. I had Lieutenant Phillips until I soloed. He's an Army flyer, one of the best. Since he left I've had Randy Enslow. He used to be Lindbergh's sidekick, barnstorming, before Slim went into the air mail. Get on Enslow's list. You'll like him fine. He

pours rawhide and that's what you want. Every instructor has a different method, but they're all topnotchers. Better money right now in instructing than any other kind of flying."

"Easier work, too," I ventured.

"My eye!" snorted Owens. "Would you feel easy, sitting in that front cockpit, with your hands and feet off the controls and some dub behind you doing everything inside out and backwards? I'd rather fly night mail over the Ozarks! How'd you feel if your student suddenly got scared and froze onto the controls? What would you do?"

I couldn't answer. Owens went on:

"YOU'D grab the Pyrene can and reach back and sock him on the head with it! Then you'd grab the controls and get her out of whatever it was she was in."

"Do students often freeze onto the controls?"

"Hardly ever."

I asked Owens who some of the instructors were.

"There's Jordanoff. He flew in the Balkan War and was a German ace in the Big War. He's flown since he was fifteen. Before that he built gliders and made parachute jumps off housetops with umbrellas. There's Johnny Wagner, a bird of about our age. Another is Bill Purcell. He used to be chief chemist for the Curtiss motor factory and perfected two metals now used in planes.

"Then there's Coth, who was a Royal Flying Corps ace. Coth soloed in one lesson of fifteen minutes! That's the way they rawhided 'em in the war. You took one lesson with an instructor, then went up solo. It was like being kicked off the dock into deep water. Sink or swim."

A mechanic walked over and said to Owens, "She's ready, Bubber."

Owens stood up and said casually, "See you later." He went to one of the blue training planes and climbed into the after cockpit. He taxied it to the end of the field and turned it into the wind. I saw the sunlight on the slowly revolving blades flash and scatter. The plane came down the field. The wheels lifted from the ground. It began to climb. The wheels were still spinning when it roared over my head.

I asked myself if I would ever be able to fly a plane with such skill and confidence. I decided to end the suspense. In the lee of a large hangar was a small white building, the office of Charles—"Chic"—Gaver, school manager. Chic Gaver was alone.

I gave him the letter I had received the previous evening from the Department of Commerce doctor who had examined me, certifying that I was physically fit to fly. And I gave him a cashier's check for $600, which represented most of the savings of three years of hard work on a newspaper. He was pleasant but very casual and businesslike. He pulled out a long orange card and began asking questions. Full name?

"Lawrence Arthur Brent."

Age? "Twenty-two."

Education? "High school."

Occupation? "Newspaper reporter. But," I added firmly, "I'm through with that. I expect to become a flyer—and stay one. I hear there's a big demand for experienced flyers."

Gaver smiled. "How are you going to get your experience—your first fifty hours?"

"I understand," I answered, "that you give students jobs and let them work for flying time."

"Not any more," said Gaver. "It didn't work out. Our first rule is safety. We won't have men working on our planes if we can't fire 'em for making mistakes. Now we hire only good licensed mechanics. If they want to spend their wages for flying time, that's up to them."

I ASKED Gaver how long it should take me to finish my twenty-five-hour course, including ground school.

"From six to eight weeks, depending on the weather. The school is open all winter. Have you decided on your instructor?"

"Randy Enslow," I said.

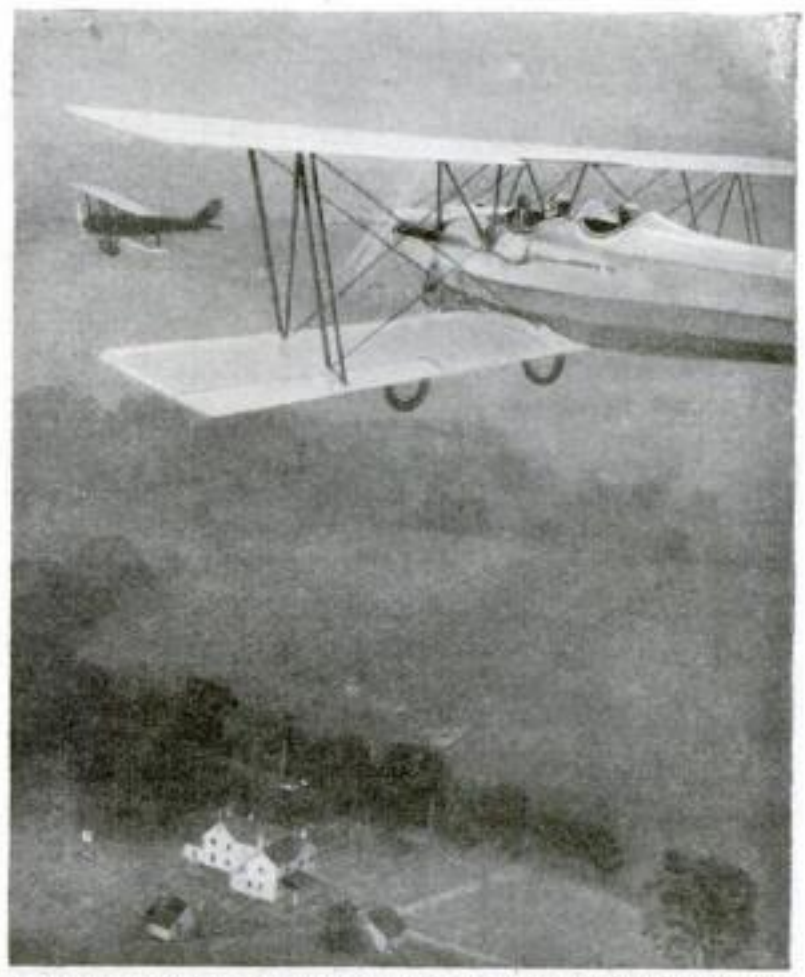
"Try to fly every day. You can forget what flying you've learned in one lesson if you skip many days. Every afternoon there's a lecture—sixth hangar down. Instructors, other pilots, and aeronautical engineers cover flying from every angle. Lectures are free. Don't miss them. If you have a pencil and paper, take down some notes. They're important."

I had a pencil and notebook. He began.

"The first point to bear in mind in flying is speed. Speed means safety in flying. Without speed, an airplane will fall like any other heavy object. It stays up because it moves fast.

"Most students have a tendency to over-control. That is, they grasp the stick instead of holding it lightly.

"Always coördinate your hand and foot muscles. Never move your stick without moving your rudder.



We were up 800 feet, sailing along beautifully, when Jordanoff raised his hands—the signal for me to take the controls. My right hand was on the stick, my feet on the pedals. I was flying the ship!

Photographs of the author by D. Warren Boyer

Jordanoff showed me how to work the ailerons. "When you push your stick to the right," he explained, "the ailerons on the right wing go up, those on the left wing go down, banking your ship."

Then he explained the rudder and elevators. You steer with your feet; the pedals turn the rudder. Your stick moves the elevators. This broken-away view shows how the mechanism is controlled.

Pushing the stick forward moves the elevator down, making tail go up and nose go down.

"Don't fly mechanically. Understand the why for everything. If your instructor does something or asks you to do something that you don't understand, ask why. In time, you'll fly by feel.

"Always ride your ship through. That is, be a part of it.

"ALWAYS fly relative to some fixed object—the horizon. Any questions?"

"How about flying clothes?"

"You can buy everything you need in the stores on the field. For winter flying you'll need warm gloves, a warm flying suit, and fleece-lined boots. Helmet and goggles are six dollars each. You can pay from sixty dollars to two hundred and seventy-five dollars for a suit. A fine leather suit with blanket lining is the most expensive. A fleece-lined canvas suit costs you sixty dollars."

"What is the hardest thing to learn in flying?"

"Landing. Taking off is difficult at first. Air work is comparatively easy. Landing is hardest because it calls for a brand-new use of your judgment of speed and distance. In driving a car you deal with one speed and one distance. In landing a plane, you deal with two speeds and two distances."

He filled out a small white card and gave it to me. The next hour I spent strolling around the flying field, watching the planes and talking with a number of students. Then I got my flying clothes and walked down to the little green sentry box which served Bill Bates, the contact man, for an office. I gave him the white card. It was a flight report card and it revealed what a raw beginner I was:

TIME IN AIR, HOURS—0. LANDINGS—0. AIR WORK—NONE.

Bill Bates said: "Enslow is sick today, Mr. Brent. If you're anxious to get started, perhaps some other instructor will take you. I'll ask Lieutenant Jordanoff."

He called to a dark-faced handsome young man in brown leather flying suit with fur collar and helmet. His goggles were on the forehead of the helmet.

Jordanoff came over. He was not smiling. Wise brown eyes took me in. Bates introduced us. We shook hands. Bates said:

"Brent is one of Enslow's students. Enslow won't be out today. Brent is anxious to get going. Will you take him?"

Said Jordanoff to me: "How many lessons have you had?"

"None."

Moving his arms, Jordanoff illustrated to me the secrets of banking. "Remember," he said, "if you turn the rudder without moving the stick to bank the ship, it will slip." Left: right bank; stick to right.

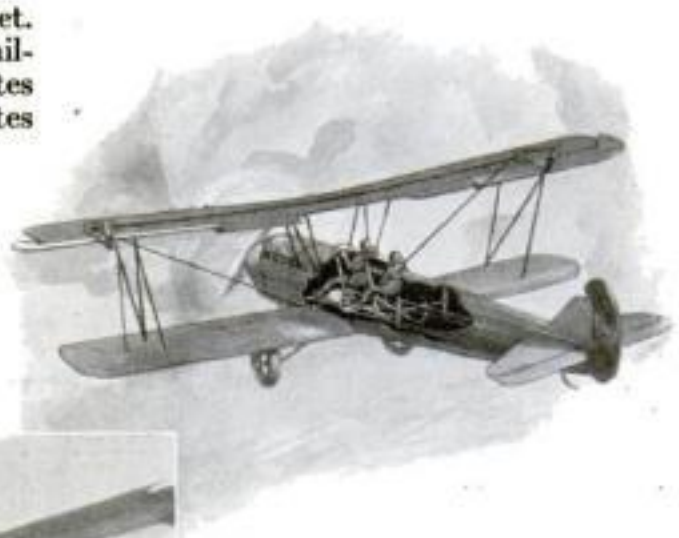
"Never been up?"

"No, sir."

"I will be delighted to take you," said Jordanoff. He smiled and bowed. Assen Jordanoff is one of the most polite men I have ever known.

We strolled toward one of the blue training planes. My heart began banging

I presented my doctor's certificate and a check for $600 to "Chic" Gaver, school manager. He pulled out a card and began asking questions.



Pushing the stick to the left tips the plane to the left, as pictured here.

when Jordanoff buckled his helmet under his chin. He smiled and asked, "Are you taking up flying for recreation?"

"No, sir; I'm going to become a commercial pilot."

That seemed to please Jordanoff.

"You look to me," he said, "as if you should make an excellent pilot."

"Can you tell by a man's looks?"

"Often."

I asked him what it was. He shrugged, smiled again. "Something about the eyes, perhaps. You have it."

I felt grateful. Swiftly Jordanoff walked me around the plane, pointing out its different parts. Then, "If you will get into the after cockpit, I will explain."

I climbed into the after cockpit. It was the first time I had sat in an airplane cockpit. My first surprise was the distance down I went. My chin was just about level with the cockpit cowling.

COMING up from the floor between my legs was the control stick, or joy stick. At the top end was a rubber handle like the grip on a bicycle's handlebar. At my feet were pedals, fairly well over on each side. They reminded me of bicycle pedals. But with them, all resemblance to being on a bicycle ended.

Jordanoff said: "Take the stick. Always remember to hold it lightly. You will be surprised what a light touch will make the plane do anything you wish. When you push the stick forward, the nose goes down. When you pull it back, the nose goes up. When you push it to either side, the plane tips in the direction of the push. It is absurdly easy."

He smiled. I tried to smile. Well—it sounded easy.

"Now for steering," went on the instructor. "You steer with your feet. When you push the right pedal, the ship goes to the right. When you push the left pedal, the ship goes to the left. Again—absurdly easy!"

Again he smiled. Again I refrained. Students had told me

(*Continued on page 145*)

An up-and-down city of 12,000 inhabitants—the Woolworth Tower as seen through the arch of New York's Municipal Building.

Running a Skyscraper

By PETER VISCHER

JAMES L. SMITH is, in a sense, mayor of one of the busiest and most spectacular cities in the world. He is operating manager of the Woolworth Building in New York, the tallest building in the world—a skyscraper city within a city. He watches over the welfare of 12,000 and more inhabitants of a perpendicular town larger than Emporia, Kan., or Reno, Nev. And he presides over a rapid transit system almost topsy-turvy in that its swift cars go straight up and down, a mart with 25,000 transients a day, police and fire departments, a hospital, a bank, great power plants, restaurants, a swimming pool, a college, a magnificent cathedral whose fine-wrought spires reach out into the very heavens.

Jim Smith is young, but the waters of his experience run deep. His mother's father directed the operation of buildings many years ago, and every one around Wall Street knows his father, Bernard Smith, for more than half a century manager of the structure that houses the New York Stock Exchange.

"Ever since I played with blocks I knew that some day I would operate a great building," he told me. "When I was graduated from Manhattan College about fifteen years ago I knew just what I wanted to do. The fever runs in the Smith family. I have a little daughter, she's seven, and when she grows up I hope there'll be women building managers. I want her to have a crack at this game."

OBVIOUSLY, Jim Smith's job looks good to him. No wonder, then, that his complication of duties hardly feazes him. He takes ceaseless activity as so much routine. He does his job deliberately, because he wants to be calm and collected, if ever emergency arises.

There's no telling what will happen in the Woolworth Building on any day. The tower of Woolworth rises majestically 792 feet and an inch into the air, and its sixty floors swarm with people.

"In a building as large as this one we have to be especially careful about things," he said, modestly, "because even the slightest of slips might tie up the works."

And because Smith has been so careful, there hasn't been a real emergency in the Woolworth Building since that thrilling night of April 24, 1913, when President Wilson pressed a tiny button in the White House and 80,000 brilliant lights dedicated the masterpiece of Cass Gilbert and brought to fulfillment the dream of Frank W. Woolworth, exalter of nickels and dimes.

Once it looked as though the crisis had come. A grimy bootblack in City Hall Park squinted up at the Woolworth Tower, frowned, and tumbled excitedly across the street shouting, "Fire!" Thousands of persons gathered, stopped, and craned their necks. High above the street, smoke seemed to be curling from the windows. At first a wisp, it quickly turned into a thick black pall.

"Mayor of Skyscraper town"—James L. Smith, operating manager of the Woolworth Building. His job is as complicated as running a city.

The superintendent's office was notified. Two leaps and Jim Smith was in the building's fastest elevator, swished up at a terrific rate. The fifty-fourth floor (still four stories from the top gallery) was enveloped in choking smoke.

Downstairs, four stories below the level of the street, the emergency fire pump was made ready. A turn of the hand and 500 gallons a minute could have been spread over the fifty-eighth story of the building at a head pressure of 820 feet. All hands were at their posts.

By this time a crowd of 30,000 or more persons were gazing up at the fire, which actually did exist but only within the safe confines of a small stove used by roofers. These rogues, seeing the beginning of excitement as the bootblack ran across the street and attracted attention, threw half a dozen staves of a tar barrel on their fire to give the mob a real thrill.

THE giant pump, ever ready for action, did not have to be used. It could easily have extinguished any fire in the building in short order.

So it happens that Smith is still waiting for the big emergency, which, if possible, he will avert. But no one has ever jumped from the Woolworth Building. Bandits have never yet attacked the fortresslike vaults of the Irving Safe Deposit Company which it houses. No elevator has ever fallen. No riot has ever taken place. And if it's humanly possible, there won't be any slip that might "tie up the works."

Most of the works are in the basement. There is the machinery for heating, lighting, and ventilating this up-and-down city. From there its traffic is regulated, its streets cleaned, and policed.

Taking one of the bronzed elevators I rode with Mr. Smith down into the basement. The walls and floors are tiled and the ceiling is enameled. Businesslike young men moved to and fro, and only the fact that they are in overalls suggests that this is not a traditional place for white collars.

"These men are engine-room workers," Mr. Smith explained. "Over there is the power plant. You know we manufacture our own light and power. We like to be independent.

"Our power plant consists of four engines and

(*Continued on page 140*)

The Biggest Engineering Job Hoover Ever Tackled

By WILL IRWIN

AS HERBERT HOOVER assumes his stupendous task as President of the United States, everyone is wondering: What will he do? What problems will he be called upon to meet? Will he write his name large in history?

Here is fact on which to base your answer—a keen, searching analysis of our new President by a famous author who has known him intimately from youth. Thirty-four years ago Will Irwin, a freshman in Leland Stanford, Jr., University in California, chose as his hero a leader of the senior class who was destined to rise to the greatest office in the land.

From the close friendship which began in those college days Mr. Irwin has gathered a deep understanding of the engineer who captured wealth from the jungles, turned disorder into smooth-running machinery, and organized vast enterprises of industry and human welfare.

What Will Irwin tells us here is of special importance because it points out clearly a thing that has been all but lost in the thousands of words written elsewhere—that the great problems now confronting our nation and its new President are those demanding engineering training and ability for their solution.—The Editor.

HERBERT HOOVER'S supporters, during the late caloric campaign, called him the second engineer who had ever stood for the office of President; the first being George Washington. In this, they merely made a flourish of politics. Washington, so far as I can find, never gave himself that title. He had practiced in his youth some land surveying, the most primitive branch of the craft; but he was primarily a farmer, a dealer in lands, and a soldier. Gigantic figure of a practical man though he was, he did not show in his public administration the engineer's mind. If he had, he would have stood a century in advance of his times. The day of the engineer was yet to dawn.

Hoover, on the contrary, is fundamentally an engineer; from his survey of Pyramid Peak, California, during the summer after his junior year in college, to his last item of executive work in the Department of Commerce, he brought to all tasks the engineer's attitude—the realistic mind, the moral obligation of approaching truth from a basis of facts, the passion for harmonious coördination of parts.

In his time, he saw engineering greatly extend its scope and usefulness. When he began, it dealt with single jobs like sinking a shaft or setting up a plant. When, in 1914, he severed his formal connection with the craft, it was taking supervision not only of gigantic industrial enterprises as a whole, but even of industries as a whole. On the basis of known facts and the laws of science, it was eliminating wastes and multiplying collective effort.

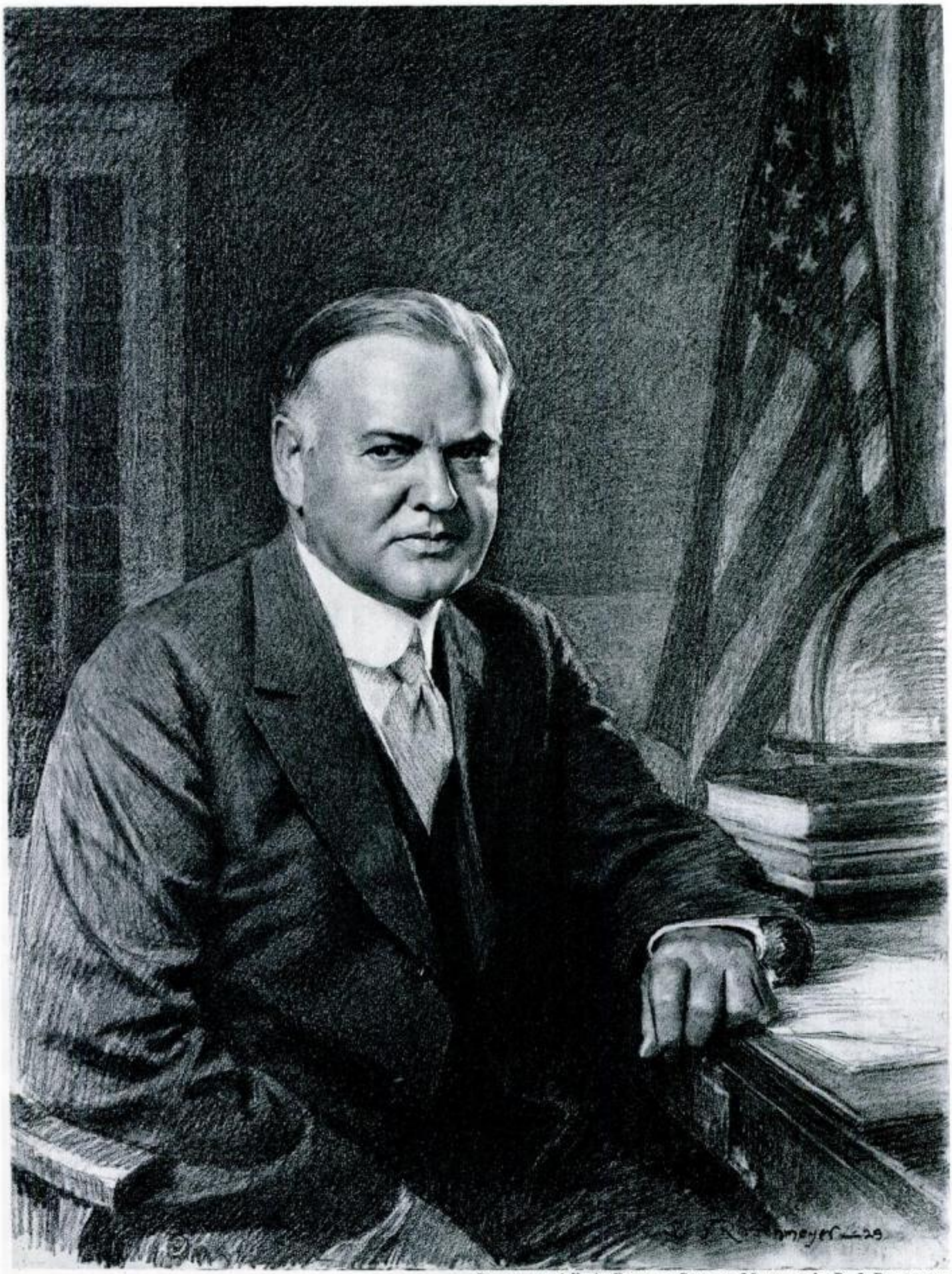
Hoover kept abreast of the times; his career is typical. He began in 1896 by reporting on mines and superintending their development. By 1914, he was making great low-grade mining properties pay dividends by the process of coördinating their complex parts. When, on a day's notice, he began his public career by taking charge of the Commission for Relief in Belgium, he broke perforce all connection with business, and seemed to be breaking with his past. He was not, really; those nineteen years of professional practice were father to his public work in the subsequent fifteen years.

The Commission for Relief in Belgium, before it became an issue of international politics, was only a great job in human engineering. All the subsequent work of his ever-widening career—the American Food Administration, the European Relief Administration, the Russian Relief, the creation of a Commerce Department that functioned—has about it the same touch. Only, it has also the human touch. The combination of these qualities is the reason why we are inaugurating Herbert Hoover President of the United States.

He had, during those nineteen years, a long, hard, and interesting apprenticeship. Here again lies a fundamental difference between Hoover and any other man whom we have ever elevated to the Presidency. All others, during their early careers, had taken part in public life or Government service; most of them had long been pointing toward the White House. But if you had suggested to Hoover, before 1914, that he would some day become President, he would have laughed. At most he held only a vague hope that in his middle age, when he had made his pile, he might pull himself wholly within the United States and get as a volunteer into what he called "the big game." That did not mean politics necessarily or even probably; just some chance to carry into wider fields that engineering method which had become an instinct.

It was a wonderful apprenticeship, however; working as though designed to mold the unique world figure that he has become. Of its central facts, the public knows little. After three years of inspection and management in our own Far West, Australia sent to California for a young man to introduce American gold mining methods, considered the best in the world. Hoover got the job. And he found, before he finished with Australia and passed on to China, a striking opportunity for a young man. In most departments of mining and in most heavy branches of engineering, the United States led the world. I am not indulging sinful national conceit, I hope, when I say this. It was just the fruit of our experience in breaking, during two generations, a wild continent of unruly rivers, intraversible deserts, and impassable mountains. Further, very few American engineers had ventured abroad. Hoover seized the opportunity. All his work, in the years up to 1914, had the same general cast. With American assistants and American machinery, he was introducing our methods into the untamed regions of foreign lands.

AND here is another superlative about Hoover. No American before or since ever operated a single private business on so wide a geographical scale. He worked personally on every continent except South America; and even there he was at times absentee manager, or expert adviser, for properties in Peru and Brazil. Nominally, he was a mining engineer. But any mining man knows that when you open a new property in wild country, you must almost run the gamut of the craft. His early Australian job, for example, involved the erection of shaft houses and reduction works—construction engineering, mechanical engineering, chemical engineering. A brief service with the Chinese government as expert geologist; then, after the Boxer (Continued on page 161)



Drawn especially for Popular Science Monthly *by B. J. Rosenmeyer*

HERBERT HOOVER, *THE NATION'S ENGINEER*

A remarkable study of our new President at his desk. The first scientist to become the nation's chief executive, he assumes his task at a time when the Government is more concerned with problems of engineering science than ever before in its history.

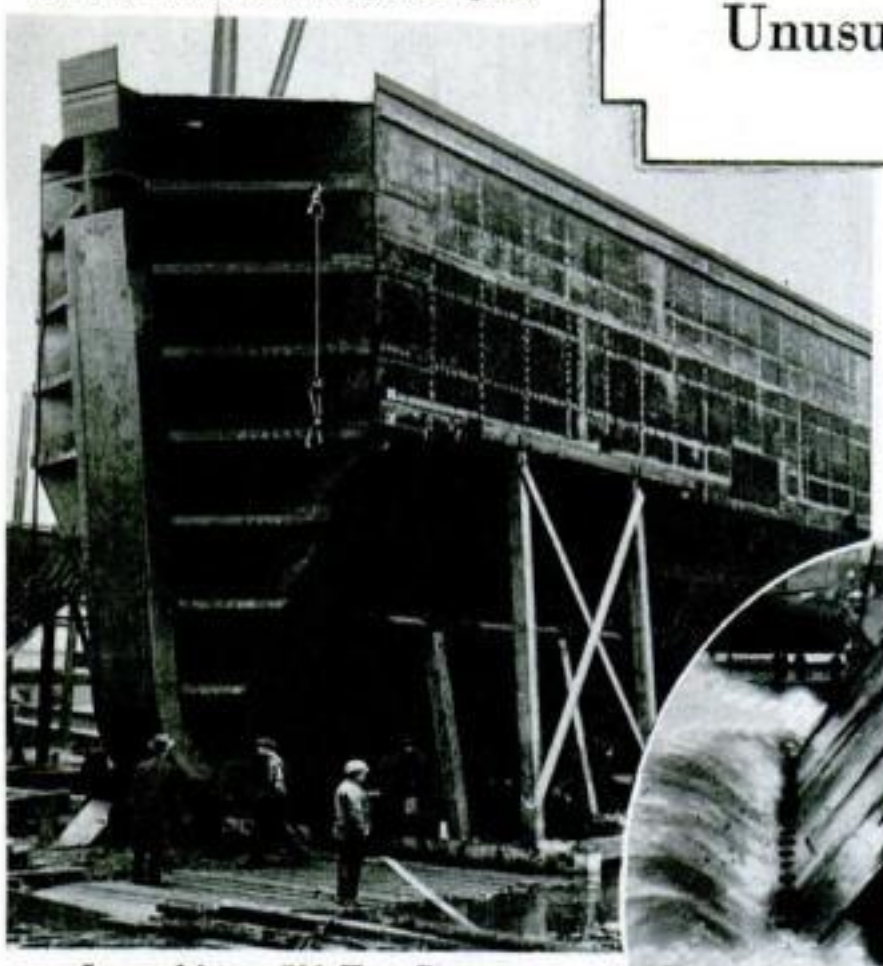
U. S. Gliders Match Skill

Camera Stories of Unusual Events

FROM coast to coast Americans are trying a hand at the thrilling sport of motorless flying. Here are views of the first official glider contest held by the California Gliders Association on the sand dunes near San Francisco. At the right a ground crew is catapulting one of the machines into the air by means of a tow-rope. Vance Breese, noted Pacific Coast pilot, is handling the craft.

Fun? Ask Charles Furgeson, president of the California Gliders Association. Here he is at the controls, ready for a glide.

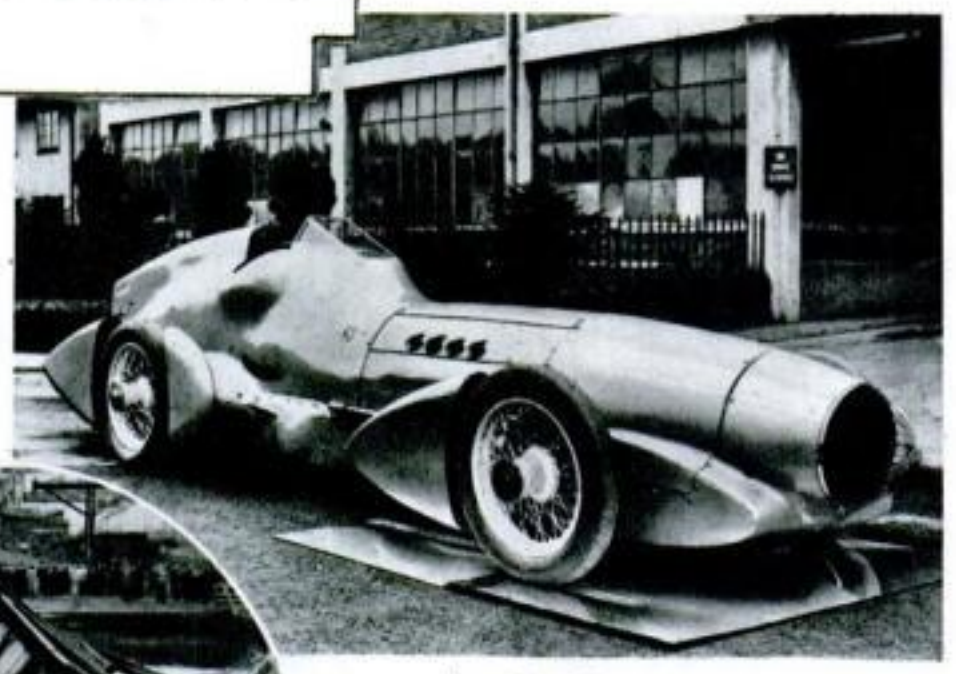
Vance Breese and his glider making a safe landing at the end of the flight pictured above. Despite poor flying conditions, he remained in the air several minutes. The glider, of the German training type introduced to America last year, was pulled into the air by men with a tow-rope, and stayed aloft by the aviator's skill in taking advantage of upward air currents.



Launching a 500-Ton Gate

RESEMBLING a giant scow, this 500-ton steel gate was launched with a mighty splash recently at Brooklyn, N. Y. It is to be the portal of a new dry dock for ocean liners in the Erie Basin of New York Harbor. This dock, 715 feet long and 113 feet wide at the top, will accommodate larger vessels than any similar structure near New York. The gate is to be lowered and raised by water ballast tanks.

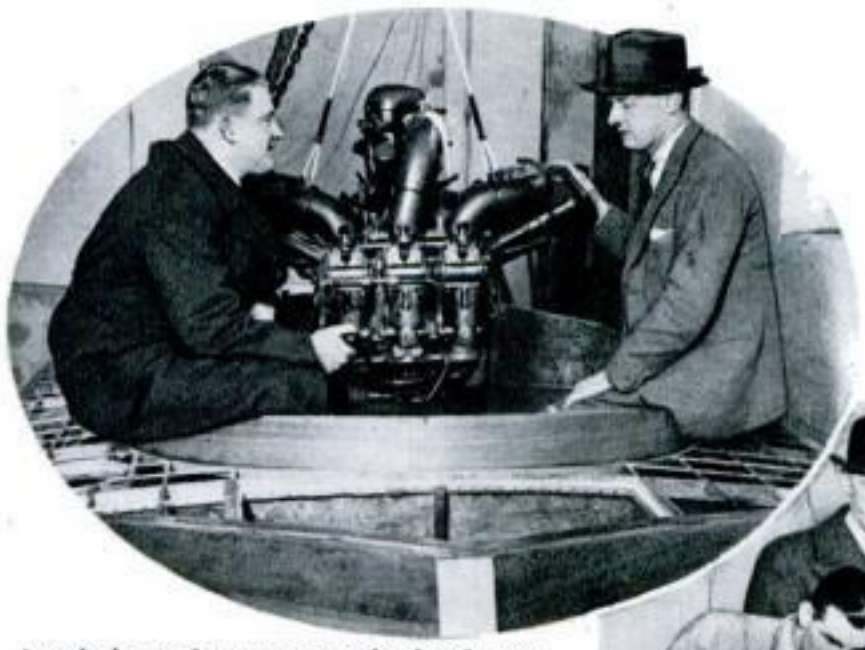
The spectacular launching of the great dry dock gate. The million pounds of steel strikes the water, churning the waves into seething foam.



Another Speedy Challenger

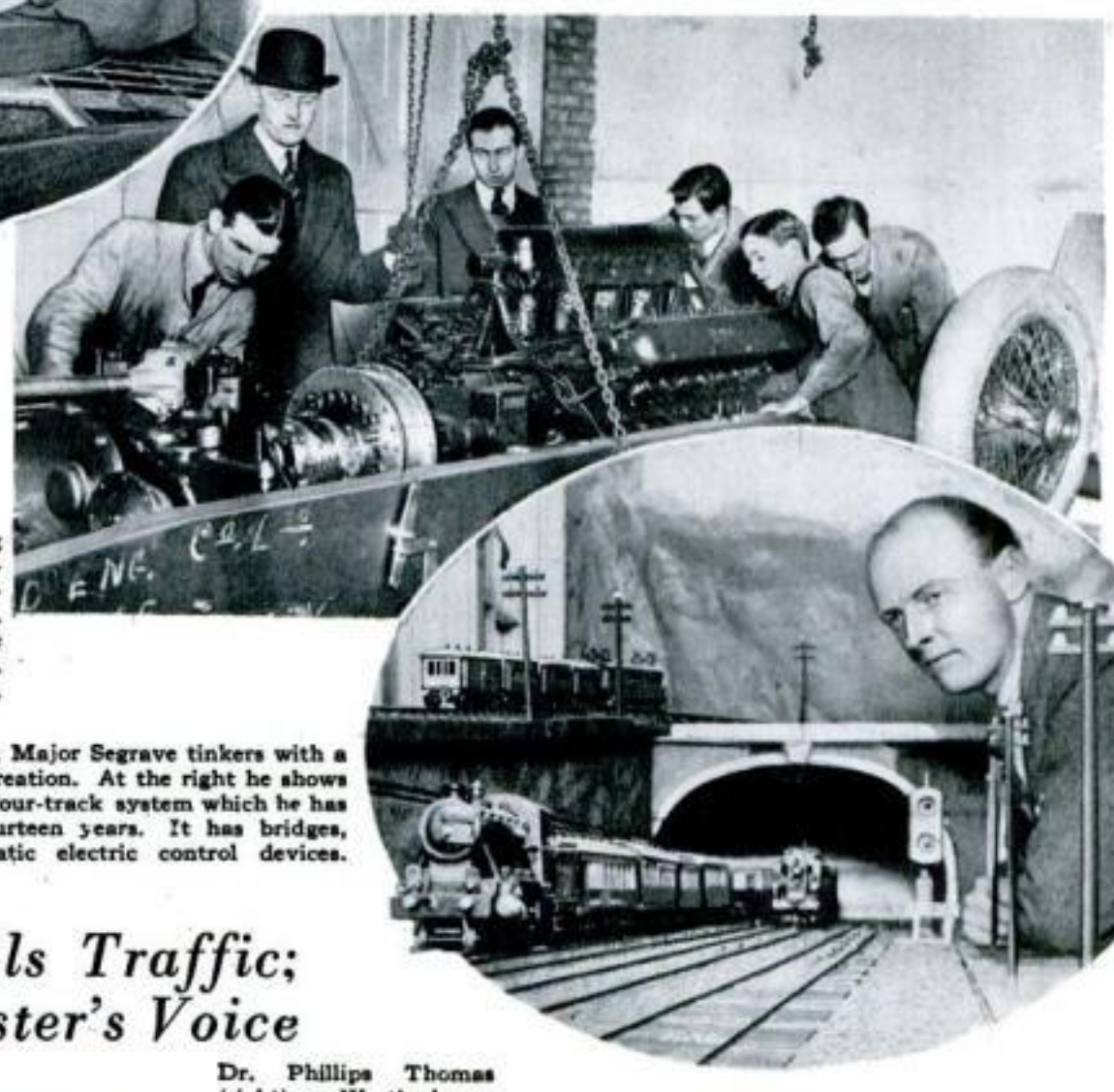
HERE is the latest speed creation of Major Malcolm Campbell, famous British driver who broke the world's record at Daytona Beach, Fla., last year, only to be surpassed soon afterward by Ray Keech, the American. Like Maj. H. O. D. Segrave, whose new car is pictured on the opposite page, Campbell expects to capture world speed honors for England this year. His new streamlined car, with a nose shaped like an airship's, is driven by the same engine which sent him at a speed of 206.9 miles an hour along the Florida beach-track.

Challenging U. S. Speed Records



America's speed supremacy on land and water is being challenged this spring by the famous British racer, Maj. H. O. D. Segrave. He recently brought to America a new speed car, the *Golden Arrow*, and a powerful hydroplane, the *Miss England*. Above: Major Segrave (right) and the giant engine in his water craft, with which he expects to beat the record of 92.8 miles an hour set by Gar Wood last year.

Major Segrave's racing monster, *Golden Arrow*, shaped like a giant fish with long, streamlined tail. With it he hopes to reach the amazing speed of 240 miles an hour at Daytona Beach, Fla.



At the right, Major Segrave (wearing derby) is seen superintending mechanics tuning up the great 900-horsepower engine of his new racer. He is convinced that it will smash the world record of 207.6 miles an hour. The car cost close to $100,000.

When he's not racing, Major Segrave tinkers with a model railway for recreation. At the right he shows part of the elaborate four-track system which he has been building for fourteen years. It has bridges, tunnels, and automatic electric control devices.

Robot's Eye Controls Traffic; Train Obeys Its Master's Voice

W. H. Jones, of the General Electric Company, with toy electric train which obeys its master's voice over telephone. When he says "Stop!" or "Go!" it responds instantly.

Dr. Phillips Thomas (right), Westinghouse engineer, demonstrates his new "electric eye" which, buried in the pavement, flashes red traffic signal when car approaches main road from side street.

This amazing robot traffic cop responds to the shadow of a car passing over it. It was invented to avoid present delays in main traffic.

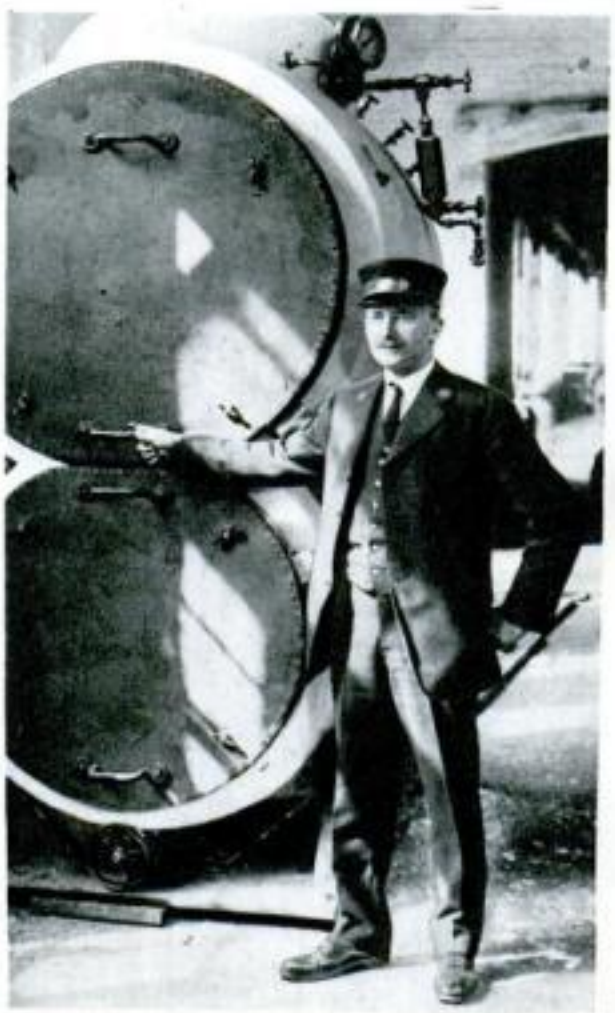
Snapshots of Unusual People

Weather forecasting is just part of the day's work for Raymond L. Ditmars, curator of mammals and reptiles in the New York Zoo.

Dr. George D. Marshall, of Kokomo, Ind., once a blacksmith, uses his mechanical skill to make his own orthopedic appliances to cure needy crippled children free of charge.

Sixty-five years old, but as enthusiastic as any young airman, is J. L. Gray, pilot of Dallas, Tex.

The world's only masters of buhl craft—the art of inlaying carved metal on tortoise shell—work in a shop near Paddington, Eng.



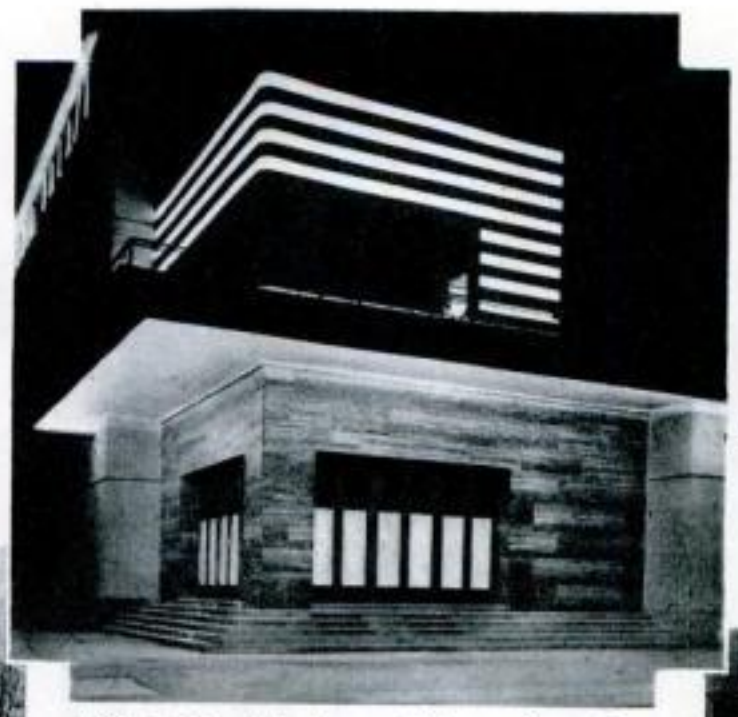
Executive of a New York firm making his new electric steam heater for trains, W. E. Hudson keeps his job as railway conductor.

Jules L. Buck, Camden, N. J., big game hunter who traps wild animals for zoos, is teaching tricks to a young gorilla captured on his latest expedition to Africa.

Seth Bert Gracier, a San Francisco chemist, claims to have discovered a way to harden gold, silver, and copper with an alloy of aluminum. Gracier is seen taking a piece of the new alloy from a crucible in his laboratory.

Odd as the House Jack Built

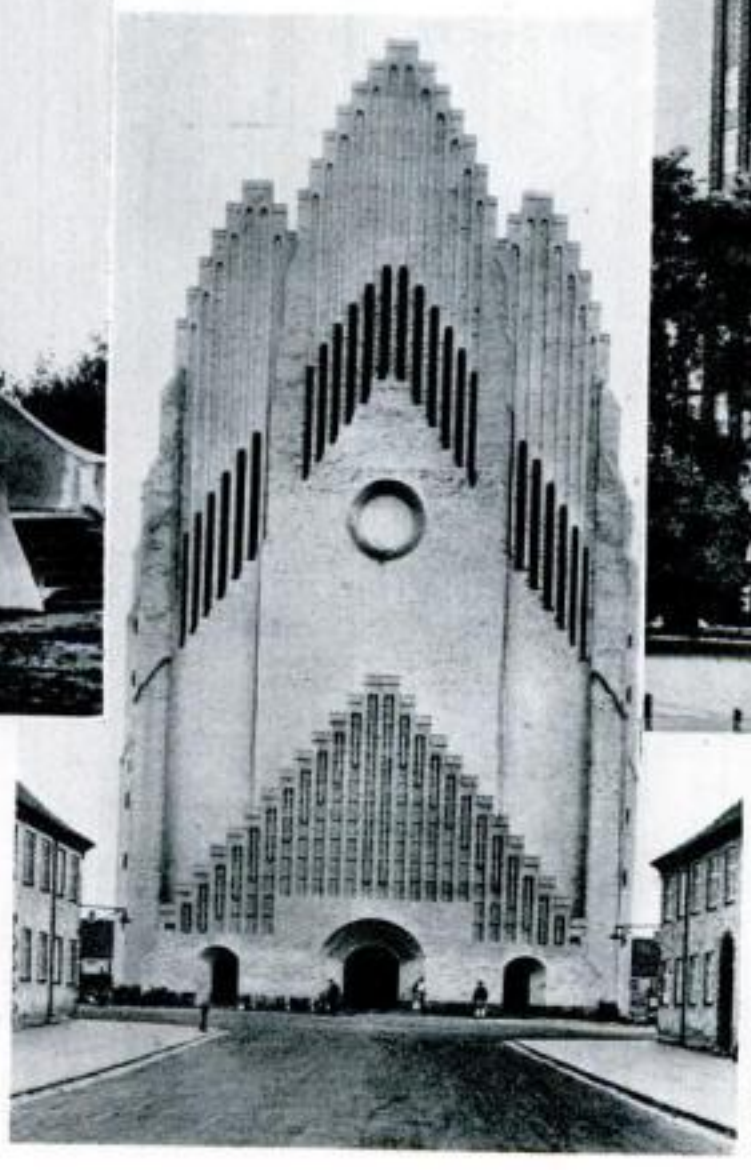
German architects transformed this old water tower in Berlin to house 100 flat-dwellers in a home of rare and charming design. Here the folk may literally "round out" their lives amidst a setting of real beauty.



Designed to catch the eye, this new film palace in Berlin is brightly illumined by horizontal bars of light that enhance its severely artistic facade.

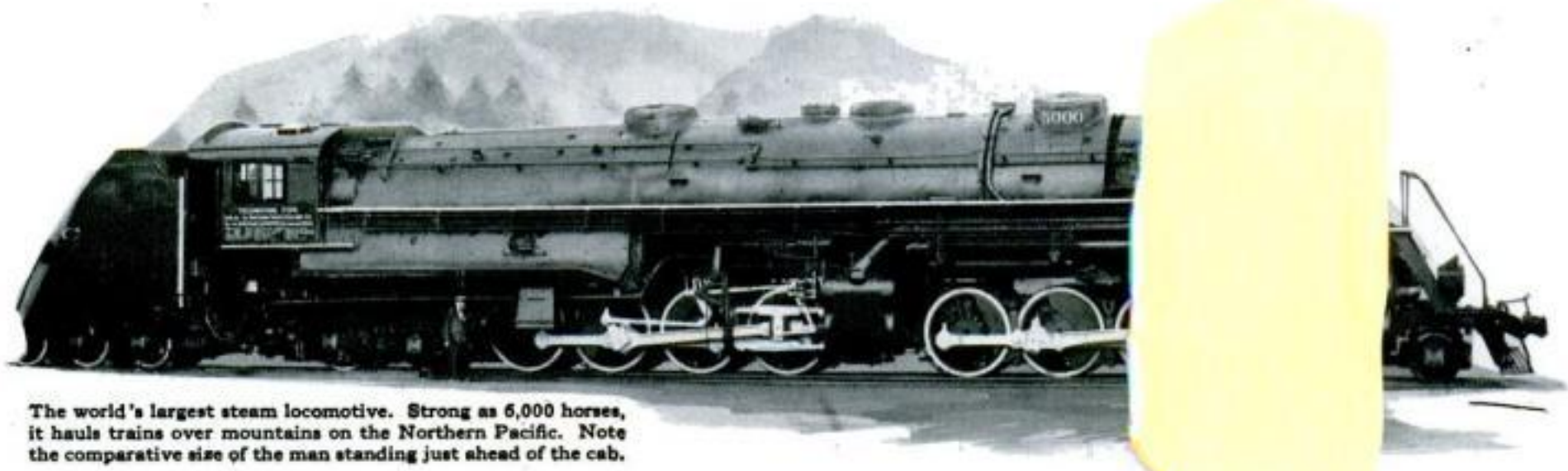
Beauty in the workaday world is achieved by the classic architectural lines that make this tall, steepled structure in Bremen, Germany, look like almost anything but what it is—the elevator of a flour mill.

This tower, which one might take for a quaint lighthouse or a new-style garage, is actually a monument to learning, for it was built to test, in every way science can devise, the relativity theories of Dr. Albert Einstein, which have upset many of the beliefs long held by physicists. In the observatory atop the tower, located in Potsdam, Germany, are wonderful instruments that put to proof the Einstein laws of light, time, and space, as applied to problems of interstellar distances, which have revised the mechanics of Sir Isaac Newton's gravitational calculations by using the idea of four-dimensional space.



Like a mammoth pipe organ towering toward the sky in daring originality of design, this stately church of truly dignified beauty is a memorial in Copenhagen, Denmark, to N. F. S. Grundtvig, a preacher who died fifty-six years ago while trying to reform religious views.

Editors and writers of the *Anzeiger* can study the stars in the planetarium atop that newspaper's new home in Hanover, Germany. Every device of modern journalism was built into this unique plant.



The world's largest steam locomotive. Strong as 6,000 horses, it hauls trains over mountains on the Northern Pacific. Note the comparative size of the man standing just ahead of the cab.

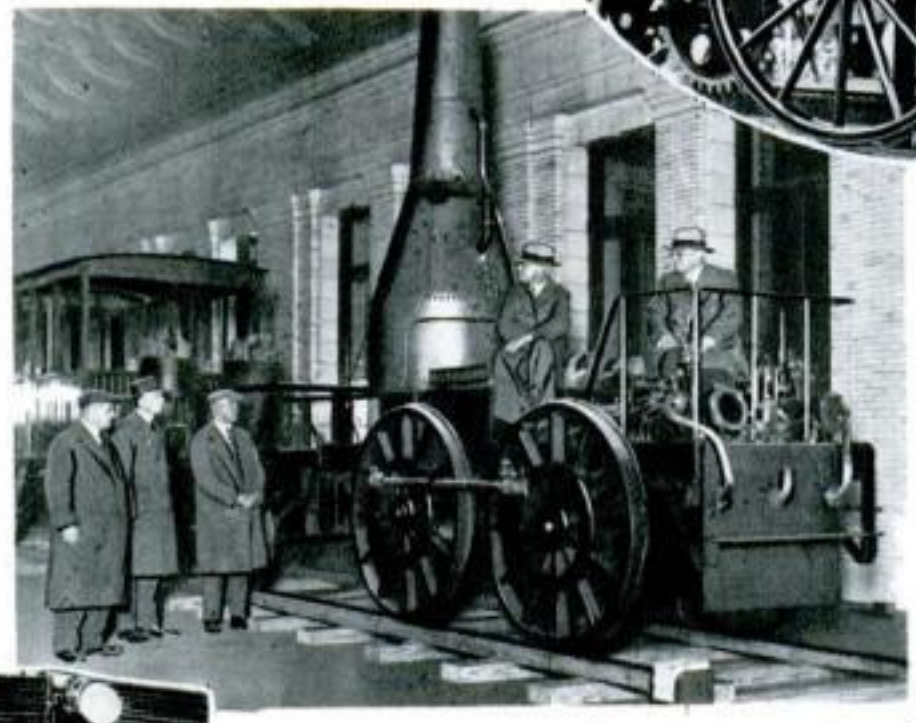
Pulls Train Two Miles Long!

Latest Engine Uses Every Hour Enough Coal to Heat Two Houses All Winter

A TWENTY-TWO-WHEELED juggernaut of the rails, the largest steam locomotive in the world, recently was delivered to the Northern Pacific Railroad. Shown above, it is the most powerful Mallet-type train-puller ever built. It weighs 1,100,000 pounds and, with its tender, is 125 feet long. In an hour it burns twenty tons of coal, enough to keep two average houses warm all winter. It will haul a double freight train two miles long on a level, but is being used to replace "double-headers" on mountain grades between Glendive, Mont., and Mandan, N. D. Its completion is a fitting climax to a century of amazing progress in engine designing.

America's railroading had its beginning when Col. John Stevens' cogwheel-driven "iron horse" pulled six persons around a circular track on his Hoboken, N. J., estate at the then terrifying speed of twelve miles an hour, one day in 1825.

Right: A close-up of America's first locomotive, built by John Stevens at Castle Point, Hoboken, N. J., where, in 1825, it carried six persons at the "terrifying" speed of twelve miles an hour on a circular track. It was driven by a cog geared to a track between the rails.



People laughed at it, yet, five years later, a boat tied up at Charleston and delivered a bulky package to the South Carolina Canal and Railway Company. It was the *Best Friend*, one of the first American-built locomotives put in operation on a railroad in the United States. In November, 1830, it was chugging over the rails at thirteen miles an hour. Seven months later, a fireman tied down its safety valve and the boiler exploded, wrecking the engine. But steam railroading had arrived for good!

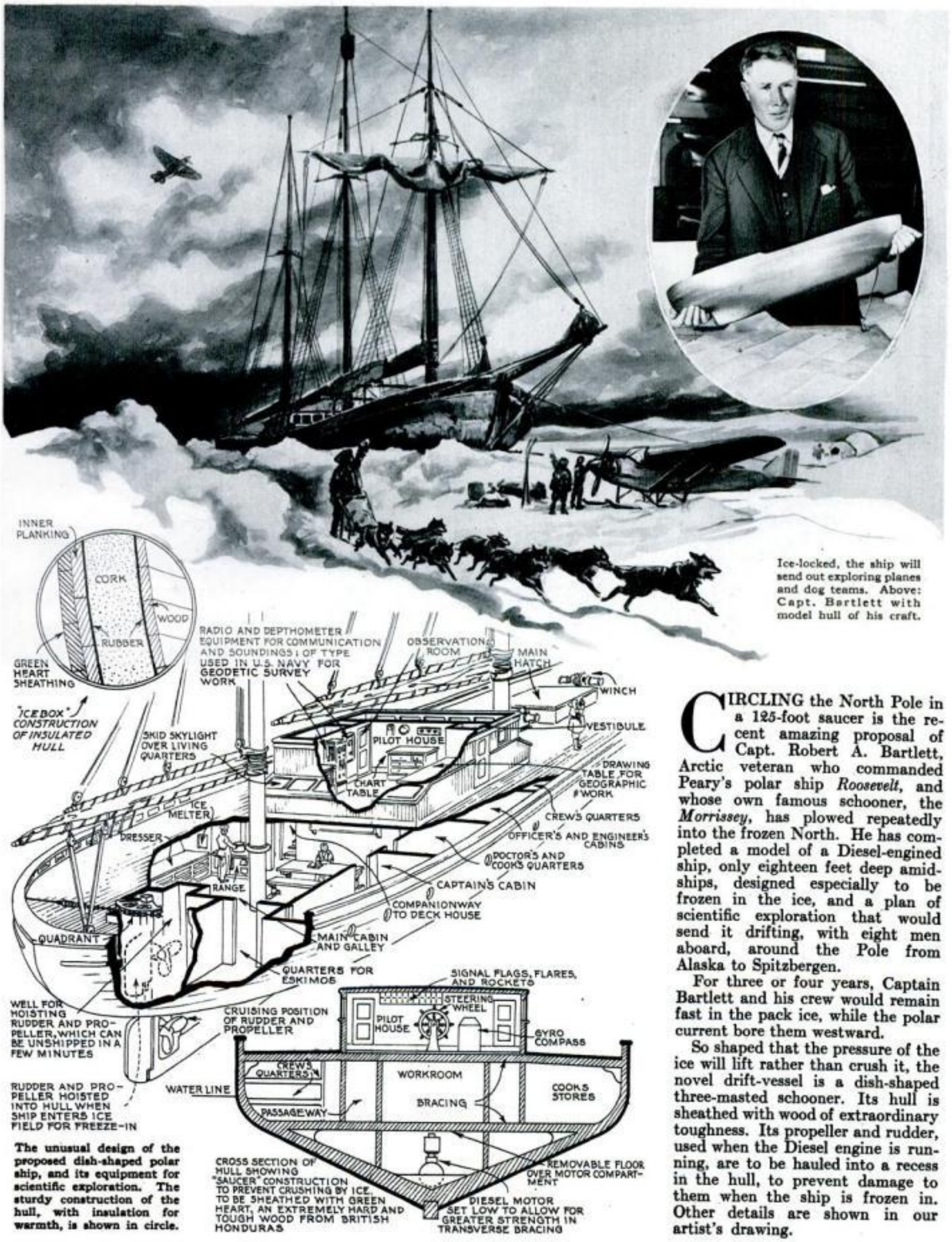
As early as 1901, a train covered the five miles between Fleming and Jacksonville, Fla., in two and a half minutes—120 miles an hour! That short distance record still stands. By 1902, there was a regular twenty-hour train schedule between New York and Chicago and, shortly thereafter, a special train covered the distance between Los Angeles, Calif., and Chicago in less than forty-five hours.

Innovations in locomotives appeared. "Electrics" replaced the steam engines on some runs. Now gas-electric locomotives promise new economies on short and light hauls. They generate their own electric power as they go, avoiding the expense and danger of a third rail. One of the latest types is shown in the lower left-hand corner of this page.

Here's a replica of the *Best Friend*, one of the first American-built locomotives. In 1830, it made thirteen miles an hour in runs on the South Carolina Railway. It was wrecked when its boiler blew up after seven months' service on the railroad.

Electricity from its own power plant propels this 400-horsepower gas-electric locomotive. It is a new development for short hauls, eliminating expense and the peril of a third rail, and has been put in operation on some American railroads to transport passengers and baggage.

Around the Pole in a Saucer!



The unusual design of the proposed dish-shaped polar ship, and its equipment for scientific exploration. The sturdy construction of the hull, with insulation for warmth, is shown in circle.

Ice-locked, the ship will send out exploring planes and dog teams. Above: Capt. Bartlett with model hull of his craft.

CIRCLING the North Pole in a 125-foot saucer is the recent amazing proposal of Capt. Robert A. Bartlett, Arctic veteran who commanded Peary's polar ship *Roosevelt*, and whose own famous schooner, the *Morrissey*, has plowed repeatedly into the frozen North. He has completed a model of a Diesel-engined ship, only eighteen feet deep amidships, designed especially to be frozen in the ice, and a plan of scientific exploration that would send it drifting, with eight men aboard, around the Pole from Alaska to Spitzbergen.

For three or four years, Captain Bartlett and his crew would remain fast in the pack ice, while the polar current bore them westward.

So shaped that the pressure of the ice will lift rather than crush it, the novel drift-vessel is a dish-shaped three-masted schooner. Its hull is sheathed with wood of extraordinary toughness. Its propeller and rudder, used when the Diesel engine is running, are to be hauled into a recess in the hull, to prevent damage to them when the ship is frozen in. Other details are shown in our artist's drawing.

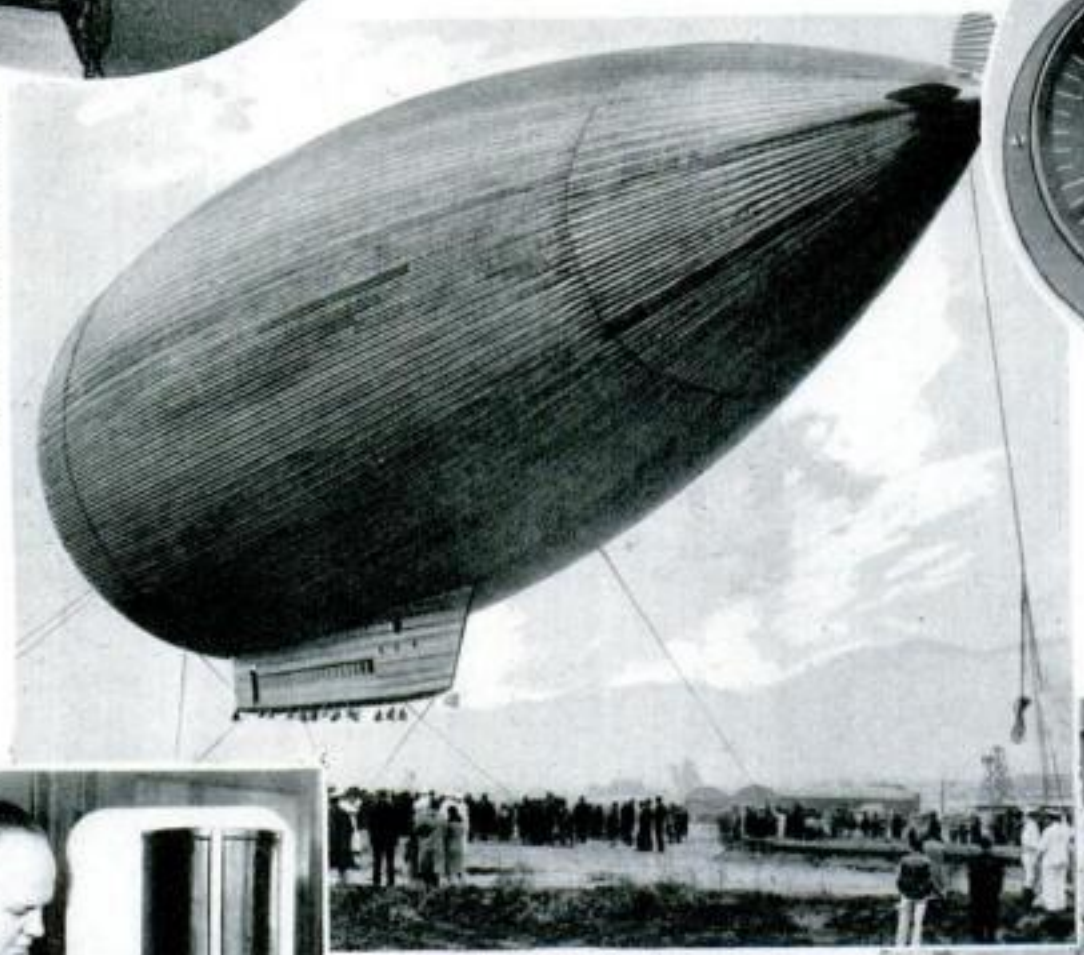
Speeding Ahead with Aviation

With ninety-foot wing spread and two 625-horsepower motors, the huge plane is designed to remain aloft twenty hours. Notice the unusually wide body shaped to increase lift.

America's latest air liner—new twenty-passenger cabin monoplane on recent test flight at Newark, N.J.

Getting new license plates is one worry of motoriststhatdoesn't bother the airplane owner. To obey U. S. Department of Commerce rules, all he has to do is to paint new letters and numerals on his machine. Lee Wiley, a Los Angeles flyer, is seen here showing how simple it is.

Constructed like a jeweled watch, this super-sensitive new altimeter registers as little as five feet in the rise or fall of a plane. The large dial is scaled in hundreds of feet, and the small one in thousands. Both dials are illuminated for night flying.



Launching the all-metal, steam-driven dirigible *City of Glendale*, described recently in POPULAR SCIENCE MONTHLY, at Glendale, Calif., for buoyancy tests.

Right: Revolutionary airplane motor invented by H. A. Palmer (right) of Boston, said to have no connecting rods, cam shaft, or valve springs, and only half usual working parts.

Left: A new airplane gasoline gage, said to be the most accurate ever designed, and its inventor, John H. Payne, engineer, Schenectady, N. Y. It measures the gas tank by weight.

Mammoth Flying Hotel for 80 Passengers—A Rival "Question Mark"—Unusual Ideas and Inventions

COLOSSAL flying hotels are reported nearing completion in Germany. Roomier and more comfortable than the *Graf Zeppelin*, it is said, is a heavier-than-air Dornier machine for eighty passengers, now nearing completion on the shores of Lake Constance. Weighing fifty tons, it will be four times the size of any known airplane. Twelve motors, of which only six or eight will normally be used, will propel this huge plane designed by Dr. Claude Dornier, famous maker of great flying boats.

Meanwhile, the Junkers works, in Berlin, is building an air liner in which fifty passengers will ride in the eight-foot-thick wings.

A mammoth Consolidated seaplane which will carry thirty-two passengers, when modified for commercial use, passed its first Navy flying tests recently at Anacostia, near Washington, D. C. Measuring a hundred feet from wing tip to wing tip, it is by far the largest flying boat in America, and is designed to compete with huge new European flying boats. It was to foster the development of such a type that the Navy ordered the $150,000 monster. Now this type is reported being considered for service between Detroit, Cleveland, and Buffalo.

$900,000 Wind Tunnel

FULL-SIZED airplanes would be tested without flying them, in a $900,000 wind tunnel proposed in a bill recently reported by the House Appropriations Committee at Washington, D. C. The project calls for a tube of enormous size. Hitherto only the action of propeller and fuselage have been observed with full-scale parts, while test of a whole plane required the construction of a miniature model.

Since Orville and Wilbur Wright gave aviation the wind tunnel a quarter of a century ago—an invention largely responsible for the airplane's invention and its subsequent improvement—these tubes through which rush man-made gales have conserved lives and dollars while they have revolutionized plane design. For perhaps as little as $100, a satisfactory model of an untried type of plane may be built and placed in a tunnel, where it reveals exactly how the finished plane will behave. No pilot need risk his life to take it into the air. The artificial hurricane that surges around the model from a powerful blower is sure to detect hidden flaws and suggest advantageous changes.

The U. S. Bureau of Standards, at Washington, D. C., owns three such tunnels, of three, four and a half, and ten feet diameter. In the smallest a blast of air moving at 150 miles an hour may be attained. At Langley Field, Va., the National Advisory Committee for Aeronautics has just completed a great tunnel twenty feet in diameter, whose 110-mile-an-hour whirlwind will test propellers and model wings of large size.

A Helicopter That Works?

CLOSELY guarded from the curious, a strange flying machine is being built for the British government at Saunders Aircraft Works at Cowes, Isle of Wight. It is an improved type of "helicopter," designed by the Italian inventor, M. V. Isacco, to lift itself vertically into the air.

Flying straight up has long been the dream of airmen; it would make landing fields unnecessary, and would hasten the day of the "flivver plane" for everyone. But such are the practical difficulties of constructing a helicopter that the U. S. Government has, for the time at least, abandoned experiments of this nature.

A year ago, the inventor Isacco approached the British Air Ministry with his design for an extraordinary helicopter—a windmill plane with a fuselage resembling the Cierva "autogiro." But where the autogiro's windmill revolves freely in the wind, without power, and consequently excludes it from being a helicopter capable of lifting itself, the two large blades of Isacco's windmill are fitted with individual motors and propellers which face in opposite directions. The theory is that the revolving horizontal vanes will lift the whole machine, which will travel forward by the usual propeller.

COVERED wagon—stage coach—railroad—and now it's the air-rail! This simple map tells the latest chapter of the amazing story of progress in transcontinental travel. It shows the route of cross country air-rail service soon to operate on schedule. Passengers leaving New York in the evening will ride in trains to Columbus. Transferring to planes there, they will stop in St. Louis for luncheon and arrive the same night in Dodge City, Kan. Boarding a train again, they will ride to Las Vegas, N. M., and there take to the air and fly to San Francisco.

New Goggles for Airmen

FIRST tests of a new anti-eyestrain type of goggles developed by the Army Air Corps at Wright Field, Dayton, O., have proved so successful that a large shipment of the eyepieces has been ordered, according to Dr. S. M. Burka, associate physicist qualified in aerial photography at the Army field.

Formerly, Dr. Burka says, many pilots refused to wear goggles because they caused headaches after prolonged use. With the aid of instruments that measured the actual effect of a goggle lens upon the eye of the wearer, experiments were carried out to devise a new goggle that could be worn eight hours, left off for eight hours, or worn intermittently, with no loss in comfort. The result was a novel lens thicker on one side than at the other, instead of the flat surface that would be expected to cause least strain. Pilots tried it and liked it. Now the tapered glass lens has been combined with a frame to give the most vision with the least glass, and is being produced in quantity.

Britain's "Question Mark"

IMPRESSED by the recent six-day flight of the American plane *Question Mark*, refueled from the air, Britain is going after a few endurance records with her own "Question Mark" plane. A giant Fairey monoplane, just completed, will attempt first to break the world's nonrefueling record of sixty-five hours in the air; then it will be flown to Cape Town, South Africa, where it will attempt a nonstop return trip of some 8,000 miles—a third of the way around the earth—to London.

The silver craft on which England pins her hopes is a streamlined monster that measures eighty-two feet from wing tip to wing tip. Its extraordinary fuel capacity of 1,000 gallons in tanks concealed in the thick wings is expected to permit a flight of three days and nights without refueling, since the 450-horsepower Napier motor and the slim fuselage are designed especially for economy of gasoline. A novel feature is a "hooter" that automatically utters a warning signal when the pilot deviates from his set course.

Two daring American proposals to fly nonstop around the world have followed the pioneer *Question Mark's* flight. An eastward flight, starting from Paris and returning via India, China, Siberia, and the United States or Canada, is the project of the Fokker aviation firm with next June the month suggested. Tank planes stationed over various cities would refuel the globe-circler on the way.

Meanwhile Col. Arthur C. Goebel, American winner of the Dole flight from California to Hawaii, plans a flight from west to east around the world, starting and ending at Wichita, Kan. He hopes to make the attempt in August or September.

The Real Fathers *of* Flight

How Wilbur and Orville Wright Climbed on Wings at Last—The Stirring, Inside Story of the World's First Powered Plane

By JOHN R. McMAHON

Where the airplane was born. View from Kill Devil Hill, at Kitty Hawk, N. C., during the recent twenty-fifth anniversary celebration of the Wrights' first powered flight.

Like the huts of explorers in Arctic wastes—the Wright camp at Kitty Hawk, 1903.

Orville, a suitcase in each hand, trudged across the sandy desert.

Orville Wright as he appears today, wearing an aviator's helmet.

PHUT! boom! Hut-phut-tut! Bang! Bang!

A fat dozing policeman sprang quickly from his back-warming chimney prop and swung his club wildly.

Dogs barked, a cat ran, small boys with ear muffs hurrahed, and shopkeepers in white aprons ran outdoors in the wintry air after their customers to find out the meaning of the terrible racket.

"'Tis a Jesse James holdup!" quoth the fat bluecoat, stalking warily toward the alley that led behind the office of the Wright Cycle Company, whence the noise emanated. Bluish smoke drifted from a shed in that alley. The murder, or whatever it was, evidently was being committed in the shed.

"Don't be afraid, folks," proclaimed a pompous citizen. "No need for alarm. The Wrights always did make a lot of noise with their homemade gimmicks. This time they're testing their own gas engine."

"Oh, a gas engine?" repeated several vaguely.

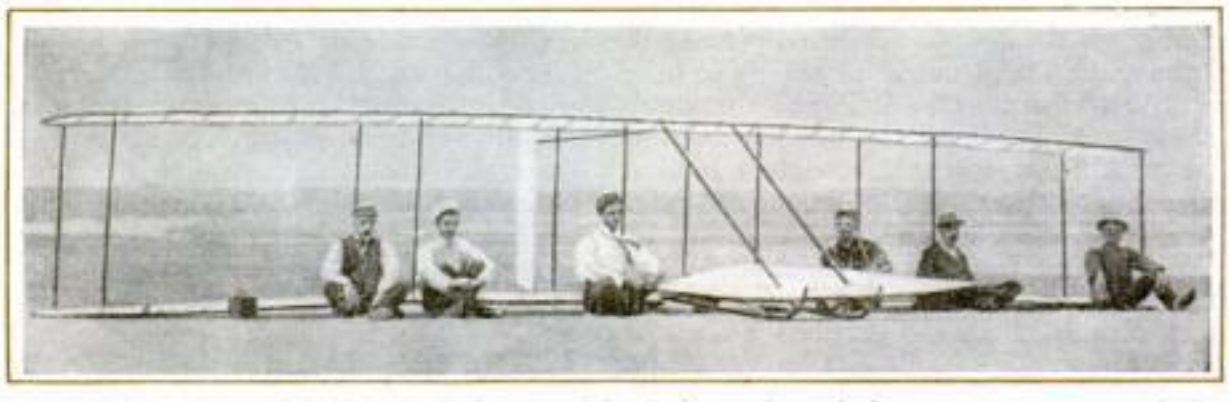
"Bah!" snorted the policeman, disgusted, yet relieved. "Well, an engine ain't ag'in' the law, but I will say this one sounds drunk and disorderly!"

Nobody in that Dayton, Ohio, crowd dreamed that the unmuffled barking, coughing, and backfiring was a noise historical—a prelude to the hum of a myriad motors in the sky—the pristine song of the airplane engine!

It was Lincoln's Birthday, Feb. 12, 1903, that Wilbur and Orville Wright gave that engine its first try-out. After three years of gliding experiment at Kitty Hawk, N. C., and epochal research in aerodynamics at their Dayton bicycle shop, they had discovered the principles of flight and planned now to embody them in a power machine. They sought to buy an engine for the purpose and wrote to several manufacturers—in vain.

"Haw, haw, letter from a couple of chaps in Dayton says they want a gas engine for a flying machine! Wastebasket, Miss Jones! Almost funny enough to keep! . . ."

While the brothers had built a two-cylinder two-horsepower gasoline motor for shop power back in 1899, they were not too confident that they would succeed with a larger engine. Internal combustion was yet a crude novelty, spark plugs were freaks, self-starters unknown. A while before Christmas, 1902, the Wrights began work on their motor which was to



The Wright glider of 1902 had all the essentials of the modern airplane except a motor. Left to right are Octave Chanute, Orville, Wilbur, A. M. Herring, Dr. George A. Spratt, and Dan Tate.

be four-cylinder, eight-horsepower, with a total weight of 200 pounds. Water-cooling and magneto ignition were planned. They made drawings and had them turned into wooden patterns for the small sum of $22. The engine case of aluminum was cast at a local foundry but the machining was mostly done in the bicycle shop by the proprietors and their only employee, Charles E. Taylor.

AT ONE time Charley was regarded as a Sancho Panza who served two Don Quixotes. He looked after the bicycle trade when they were at Kitty Hawk, made whatever queer things were required, was utterly loyal, and remained through the years as permanent a feature of the Wrights' shop as "faithful Carrie," the housekeeper, was in their home. They treated him with affectionate familiarity. Needless to say, Charley was a good mechanic.

If the neighbors were scared by the noise of the new motor, its makers were afraid, too. The racket was worse than that of their boyhood creation of a turning-lathe which had drowned out a cyclone. They noted a demonic engine speed of 900 revolutions a minute and did not imagine that twice as much speed would become ordinary. The horsepower was a little better than planned. Charley Taylor was sickened by the smoky exhaust which filled the shed. Another test was made next day, when dripping gasoline deprived the bearings of lubricant so that they "froze," breaking the engine body and frame. After repair, the motor spurted to sixteen horsepower for a few seconds but settled to a steady gait of twelve. If the pistons had been glass smooth and the other parts made to correspond, the engine with its four-inch bore and four-inch stroke would have had almost three times as much power.

"The Wrights flew because of their engine," is an old bedtime story. "You see, children, internal combustion gave us the automobile and then the airplane."

Children, I assure you this is a fable.

In the first place, the Wrights established the principles of flight without power and thereby made possible all-day motorless gliding, which promises further gorgeous development in free, birdlike travel. Then their motor was much inferior to the engines of their predecessors.

"The Wrights flew in spite of their engine," is the correct version of that bedtime story.

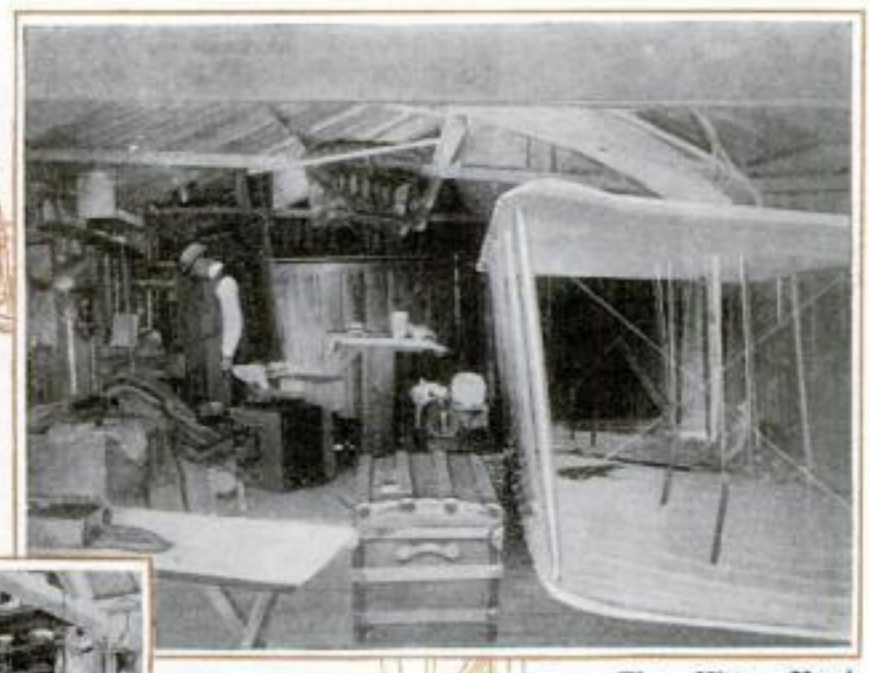
The next job after the motor was to design propellers. It looked easy. Simply take a water screw and adapt it to the air. But the brothers learned with surprise and chagrin that there was no help for them in marine screws, which after half a century of use were shaped by rule-of-thumb instead of science. Even a dozen years after this date, Orville Wright pointed out to me that the steamship *Caronia* of the Cunard Line was then changing its propellers in the hope that a new style might perhaps yield a little more push.

Charley Taylor, mechanic who served the Wrights for years, and helped build the first plane.

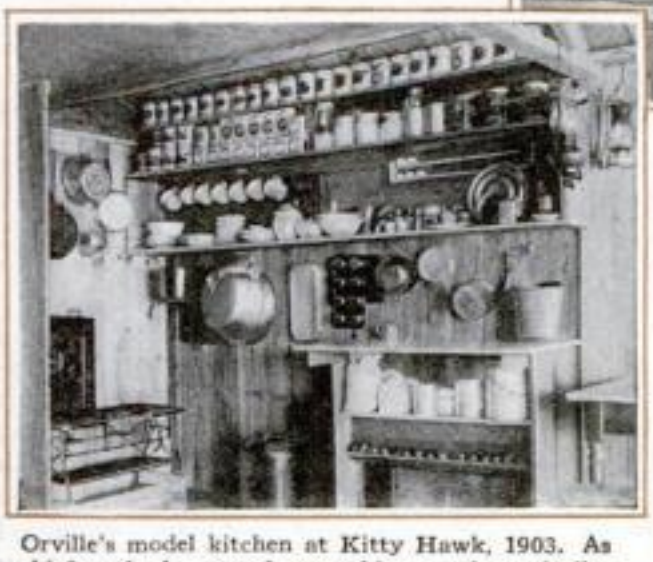
Sir Hiram Maxim had got nowhere with his tests of numerous tiny propellers of all kinds of shapes. Professor S. P. Langley of the Smithsonian Institution had mounted an air screw on a flat car which was whisked over a track half a mile long. He obtained a dusty answer.

The Wrights learned from a marine authority that almost any guesswork screw would be fifty percent efficient and at first they were inclined to try the recipe. Then they resolved to tackle the problem with science. They saw that the blades of a propeller were curved surfaces like those of an airplane wing, although the former moved in a circular instead of straight path through the air. A screw is a wing, yes, but it travels sidewise, at the same time advancing and also kicking the air backwards. How can you apply the formula of the wing table to a complicated, ornery, multiple-actioned, logarithmic, mean, and mulish pest of a propeller?

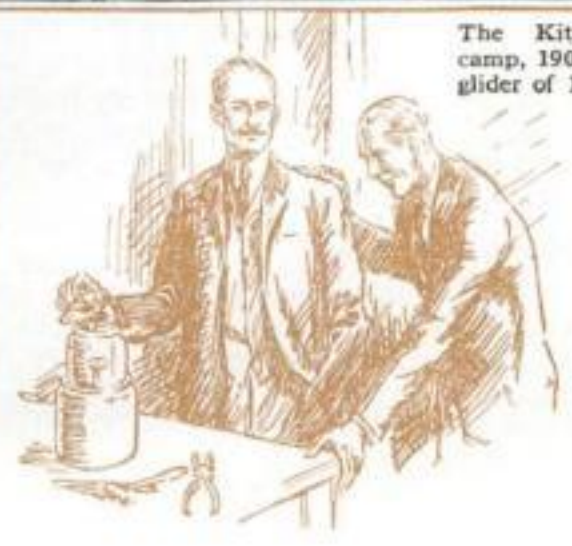
They ran in often to warm themselves over their carbide can stove.



The Kitty Hawk camp, 1902, showing glider of 1901, right.



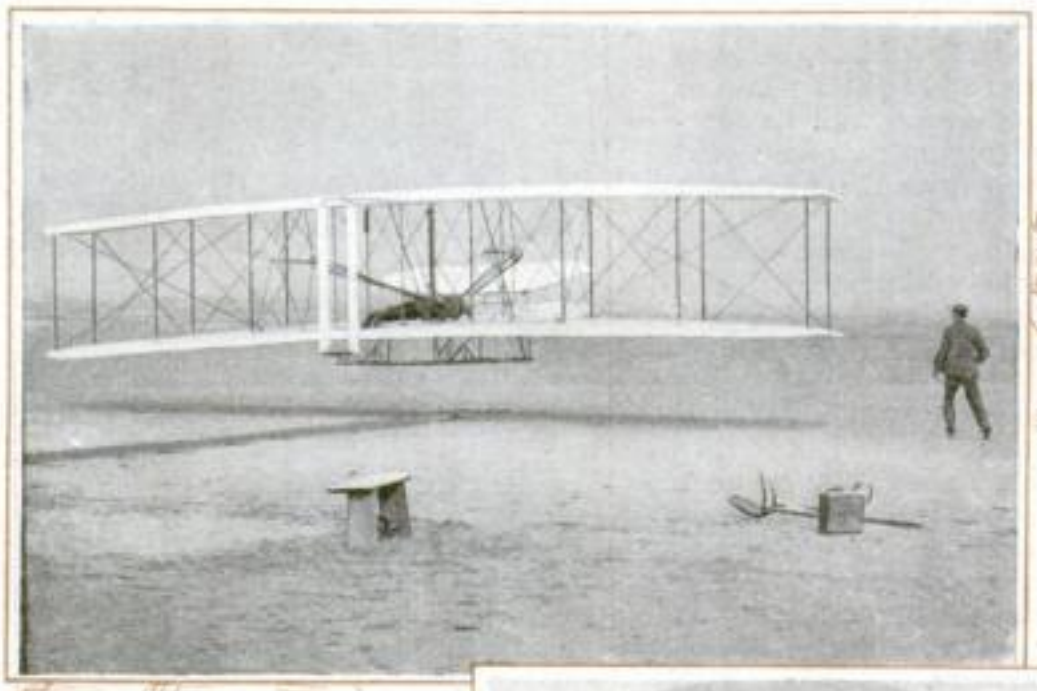
Orville's model kitchen at Kitty Hawk, 1903. As chief cook, he sorted everything mathematically. Incidentally, he invented a French drip coffeepot.



ARCHIMEDES moaned for a fulcrum to support his world-moving lever. The Wrights yearned for a fixed point whence they might begin calculations. We can imagine their fervent cry:

"Give us the angle of incidence at which the screw blades hit the air and we will do the rest!"

Nobody in the world was then donating angles or any other useful data on flying, so the brothers buckled down to help themselves. In earlier stages of their invention they had held long and vigorous debates, each fighting the other's position with all his might, so as to arrive at truth. But no previous debate compared in intensity and duration with the one



The first airplane flight in history, December 17, 1903. The machine, with Orville aboard, flew 100 feet.

The bucking glider crashed, hitting Wilbur on the head.

In a gale which nearly wrecked the camp, the brothers saved the roof.

Memorial tablet recently unveiled on the site of the first airplane flight. At the left is Orville Wright. With him are U. S. Senator Hiram Bingham, of Connecticut, and Amelia Earhart, first woman to fly the Atlantic.

now begun. In the scant-ceilinged living room of their simply furnished home on Hawthorn Street and in the little bedrooms upstairs, they hurled angles, sines, and tangents at each other. The argument excelled the talking marathon record of Congress, for it went on for days, weeks, then months! Their sister Katharine—who with their father completed the household—was at first a fascinated auditor. She hastened home from teaching a high school class to hear another mystifying set-to in a region of rarefied science. She lost her zeal to listen and stopped coming home early. The brothers were getting tired also. Their nerves became frazzled. Screws in perpetual motion spun within their throbbing heads.

"IF YOU don't stop arguing I'll leave home!" cried the exasperated, almost hysterical Katharine one day.

It was a sobering shock. They cared more for their sister than for all science. Their fevered minds were cooled by the ultimatum, and—presto!—they saw the solution of their problem and knew how to design a propeller according to the formula of their air tables.

A single screw has a gyroscopic effect that tends to hold an airplane on a fixed axis and to resist steering, so it was decided to have two propellers whirling in opposite directions. Each was made of two lengths of two-by-four spruce glued together, shaped with a drawknife and other tools, often calipered to meet the dimensions of the mathematical pattern. The twin blades were eight and a half feet long and six inches in width at the tip. Half a dozen years later the world's pilfering copyists were puzzled whether to use one, two, three, or four blades on a propeller and had no idea how to obtain the correct pitch.

The Wright screw was fixed to its shaft with a sixteen-inch metal strap, wood screws, and a portion of the ever-ready shop panacea of the inventors—bicycle cement. It stuck for them and they stuck by it to the last aircraft they built. But it was a problem how to connect motor with shaft. Belts and locally obtained chains were a failure. Then an Indianapolis firm supplied a sprocket chain that was satisfactory and was used by the brothers ever afterward.

IN ORDER to give one propeller a motion in reverse of the other, one chain was made to cross itself like a figure eight. Doubtless this was a crude expedient as later pointed out by Lilliputians of refined mechanics. The bare chains flapped, rollers were not a success, and finally the chains were cased in metal tubes in which they ran with slight friction. The transmission loss by chain drive, instead of having screws on engine shaft, was figured by the makers at five percent.

A shop test of engine and transmission, with fans substituted for propellers, was made in May and showed the first two features satisfactory. Since the motor had more than its expected power, it was planned to increase the total weight of the airplane with its operator from 600 to 750 pounds. The added weight was put into heavier or strengthened parts.

IT SEEMED to the pioneers that a machine so massive, four times as heavy as a glider, having the power of a dozen horses or more than one hundred men, would need to be exceedingly strong. So they braced and fortified and had liberal factors of safety beyond the calculated strains on every part. They did their best with wood and common metal, lacking vanadium steel and duralumin. It is noteworthy that no Wright machine, experimental or finished model for the market, ever failed through preventable structural weakness—a record unique and an example in conscientious workmanship.

The inventors started on their history-making fourth-year trip to Kitty Hawk on September 23 and arrived two days later at their old camp near Kill Devil Hill, the largest of several dunes on a sandy strip of wilderness between Albemarle Sound and the Atlantic Ocean.

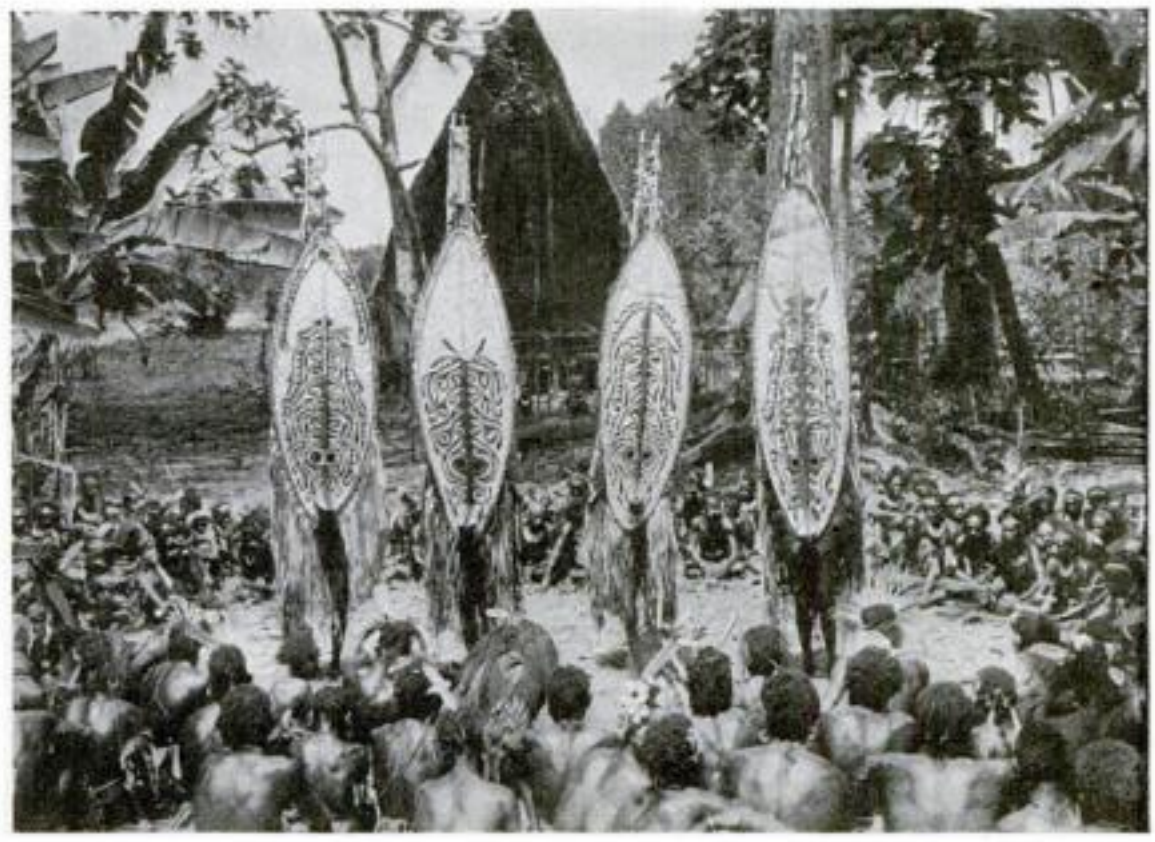
THE next day Orville wrote a jocular letter to "Dear Swes"—his sister Katharine—saying everything was in fair shape and reviewing the past marvels of Kitty Hawk, from a 107-mile-per-hour wind that had torn away the anemometer cups to the hordes of mosquitoes that dimmed the sun and the lightning that made day out of night. Orville also stated that he had worked about half a day devising a French drip coffeepot which would obviate the use of eggs for clearing the beverage, a worth while endeavor in view of the local egg scarcity. At the end of the amusing missive it occurred to the writer to add that the new camp building was (Continued on page 156)

Witches — Still on the Job!

How the Human Mind, Craving Miracles, Manufactures Them and Deceives Itself

By ARTHUR A. STUART

"Charms against the evil eye." Part of the paraphernalia of a Hungarian witch-doctor.



Among the primitive tribes in the wilds of New Guinea, witchcraft is still practiced. This photograph shows four native witch-doctors in weird garb, casting their magic spells.

TWO hundred and thirty-seven years elapsed between America's two famous witchcraft trials. As a result of the first, the "witches" were hanged; as a result of the second, the people who killed the professed witch, or "hex," were sentenced to life imprisonment. The legal point of view about witchcraft has changed.

Early in 1929, to the amazement of every intelligent person in the civilized world, a brutal murder in York County, Pennsylvania, revealed that the belief in witchcraft still persists in the United States. John H. Blymyer, a "pow-wow doctor" or practitioner of so-called witchcraft; Wilbert Hess, a boy of eighteen, and John Curry, fourteen, were arrested on the charge of having murdered Nelson D. Rehmeyer, another "hex" or witch-doctor. They had gone to Rehmeyer's house to see witchcraft performed, and Curry, at Blymyer's instigation, killed the old "hex" with a stick of wood because he was "hexing" Blymyer. Blymyer and the Curry boy were sentenced to life imprisonment, Hess to a shorter term.

A typical Hungarian witch, called "javasasszony"—a peasant woman dealing in magic herbs. There's the black cat, umbrella, and all.

In Salem, Mass., in the winter of 1691–92, several hundred women and girls were arrested and charged with practicing witchcraft. Nineteen of them were hanged, after trial and conviction, on no other charge than that of being witches. One man was pressed to death under a heavy door for refusing to plead to a similar accusation!

Everybody believed in witchcraft in 1692; only the ignorant and uncivilized believe in it now. But as three quarters of the world's population is still ignorant and uncivilized, it may fairly be said that belief in witches is still widespread.

The witchcraft believed in and practiced in York County in 1929 derives straight from Europe, whence it was brought by German settlers who came to Pennsylvania in the eighteenth century. The Salem witchcraft, however, was of American origin. Tituba, a West Indian slave owned by the Rev. Samuel Parris, minister of the Salem village church, taught ten girls palmistry and sleight-of-hand tricks as practiced among the Carib tribes, and talked so much about the magic powers of the "medicine men" of his native island that the girls, the oldest of whom was seventeen and the youngest nine, swallowed the witchcraft idea whole and accused Tituba and two old women whom they disliked of having bewitched them. The old women and Tituba were hanged, and the whole village caught the witchcraft infection. Everybody who disliked anybody else hurried forward with an accusation of witchcraft, often to be accused in turn of having caused a farmer's cows to go dry, or of making midnight flights on a broomstick to do injury to someone far away.

This present-day medicine man was found practicing his magic spells in the province of Amur, northern Siberia.

The essence of witchcraft is belief in the ability of a witch to influence others by supernatural means, to cause death or illness, bring lovers together, blight an enemy's crops, or change babies in their cradles. It is found in all early religions. The ancient Jews believed in witches but did not tolerate them. The Christian church held to the belief in witchcraft for centuries. The Church itself undertook the punishment of witches. There were executions for witchcraft in England long after the Salem trials.

Many scientists have attempted to explain the prevalence of the belief in witches. Students of the subject generally agree that the witch usually believes in his or her own powers. The idea that hypnotism and the power of suggestion, still only vaguely understood by psychologists, have actually been exercised by so-called witches, is accepted by many.

The term "hex," used by the Pennsylvania Germans to designate a witch, derives from the (Continued on page 138)

Back of the Month's News

By

KARL VOOGHT

THE daily news bulletins telling of the grim battle for the life of King George V. of England drew world-wide attention, not only because the ruler of an empire lay near death from pneumonia, but because at his bedside were gathered perhaps the greatest force of diverse sciences ever focused on one task.

Most of us, in case of illness, usually consider we have done the utmost when we call in the doctor. But to restore King George to health, it was deemed necessary to depend not only on the physician and surgeon, but also on experts in other lines—the bacteriologist, the biochemist, the X-ray physicist, the physiologist. They combined their knowledge in a concerted attack, with the result that at this writing the King was slowly mending.

They demonstrated what science can accomplish by teamwork. The day is passing when a single specialized branch of science attempts to achieve results alone. In industry the problem of the engineer, for example, has become a problem also for the chemist and the physicist. In the same way the war on disease is enlisting research workers in many fields other than medicine.

According to Dr. Charles H. Herty, of New York City, every year more than 100,000,000 people suffer from various kinds of sickness, representing an economical loss of billions of dollars. What is needed, he believes, is a permanent alliance of the branches of science to improve health conditions.

A bill, recently introduced in the Senate of the United States, would provide a national institute of health, headed by a grand council of experts representing and focusing the different sciences on the conquest of disease. Such coöperation would win battles that medicine, fighting lone-handed, would lose.

Rescued from the Tree Top

It was a lucky day for Thomas Hatton, a student pilot of Scranton, Pa., when his plane crashed into a tree top at Cincinnati, O. Not only did he escape injury, but a hook-and-ladder company was there to bring him down, and a photographer was on the spot to take this unusual photograph of the rescue. Accidents such as this are becoming fewer in number, thanks to better airplanes and improved guides for pilots of the air.

Five Million Volts!

WITHIN a quiet building in Pittsfield, Massachusetts, a group of men are experimenting with the world's most dangerous plaything. It is a 5,000,000-volt thunderbolt of laboratory lightning. Only once before has an attempt been made to produce such voltage. This took place a few months ago, during a spectacular experiment at the Carnegie Institution, Washington, D. C., and was described in POPULAR SCIENCE MONTHLY.

At the Pittsfield high-voltage laboratory of the General Electric Company, four generators, each producing a million and a quarter volts, were hooked up together. Their combined discharge is one twentieth as powerful as the actual bolts that streak across the sky during thunderstorms. Various uses have been suggested for these record artificial lightning flashes. In one experiment, they will be flung at model transmission lines within the laboratory to discover new facts about the effect of lightning on high-voltage wires.

In recent years, experimenters have measured electrical pressure up to 10,000,000 volts. They have discovered the length of time it takes a cloud to discharge its electricity as lightning.

Recently an Austrian scientist estimated the value of the power wasted during an electrical storm. It would cost a million dollars to put on a few minutes of Nature's heavy electrical fireworks, with frequent flashes of lightning. By learning the secrets of these lurid flashes through laboratory experiments, science hopes someday to capture their waste electrical power and put it to work.

BEHIND every important new discovery or invention lies a story. Behind hard-sounding technical names and phrases usually can be found a wealth of wonder, adventure, and understandable knowledge. You'll enjoy the little stories which make up this feature each month. And we believe you'll find them valuable in adding to your store of information.

Poison in Comets

CYANOGEN, one of the most deadly of all poisons, recently was discovered in the heads of comets by Dr. N. T. Bobrovnikoff, of Lick Observatory, by means of a spectroscope. He found also that the comet's tail is almost equally dangerous, for it is full of carbon monoxide, the same deadly gas which is given off by an automobile exhaust.

These discoveries are of particular interest because comets have always been regarded by primitive men as portents of evil. Even down to very recent times the appearance of a comet has been sufficient to send whole communities, even nations, into panic. Milton, in *Paradise Lost*, says of a comet that "from his horrid hair shakes pestilence and war." The comet was a mysterious stranger, upsetting the orderly procession of the stars in their courses, and might bring dire disaster in its trail.

Were primitive peoples afraid of comets merely because they were terrifying specters in the skies, or did the tail of a comet once brush close enough to the earth to poison a considerable proportion of its inhabitants, the tale of which catastrophe, handed down through countless generations, gave rise to the belief that comets are messengers of evil?

Nobody knows, any more than science can tell today, how the cyanogen gets into the comet's head and how cyanogen is converted, as it seems to be, into the carbon monoxide of the comet's tail.

Dyeing the Blood to Keep You from Dying

A NEW scientific offensive has been launched at Stanford University, California, where two chemists are pumping dyes into the blood of rabbits, pigeons, and guinea pigs as a remedy for diphtheria, ptomaine poisoning, snake bite, and other diseases and poisons. Through their tests of small animals, the chemists, Professors Butt and Hanzlik, expect to determine whether human be-

ings will respond to the same treatment.

They have fed a rabbit enough strychnine to kill an ox, then saved its life by "shooting" Congo red into its veins. Pigeons similarly inoculated with cobra venom, guinea pigs with diphtheria germs, and rabbits with ptomaine poisoning all have been restored to normal health by the color treatments.

So far, Congo red has proved the most effective dyestuff remedy. It seems to possess peculiar properties in combating the poisons that seep into the blood. Thus the dyes, or "paints," act as strong and efficacious antidotes, enabling the white corpuscles of the blood—the real healing agents of the body—to battle victoriously against the bacteria that threaten to overwhelm them. The California chemists also hope that their discovery eventually will enable medical science to prolong human life by eliminating from the blood the poisons that create many old-age ailments.

Oil for Auto Fuel

A YOUNG inventor from New Zealand, Ernest Godward, recently brought to America a device which he thinks may save bus owners in this country $50,000,000 a year. His invention enables the ordinary gasoline motor to run on cheap fuel oil, such as is used in oil-burning furnaces.

Twenty Philadelphia buses have been equipped with the invention and have run nearly 300,000 miles over steep, hilly roads. Six hundred additional interurban buses of that city are being fitted to burn the heavy oil. Motors burning the new fuel are said to start as quickly as when using gasoline and to show an increase of as much as fifteen percent in horsepower. Unlike Diesel engines, motors equipped with the Godward device can use either oil or gasoline.

The invention is described as an aluminum pot in which is set a nest of stationary, thin, curved plates radiating from a central core. This pot is heated by the exhaust. The oil, drawn through a carburetor, passes over the surface of the warm plates, where it is converted into dry gas before reaching the cylinders. The inventor designed a simple apparatus to test the efficiency of motors. It measures the unburned gas coming from the exhaust pipe.

In other tests, airplanes were operated on heavy oil instead of gasoline. And Dr. Joseph S. Ames, of the National Advisory Committee for Aeronautics, predicted in POPULAR SCIENCE MONTHLY that eventually special Diesel engines burning the less expensive fuel might be installed in planes.

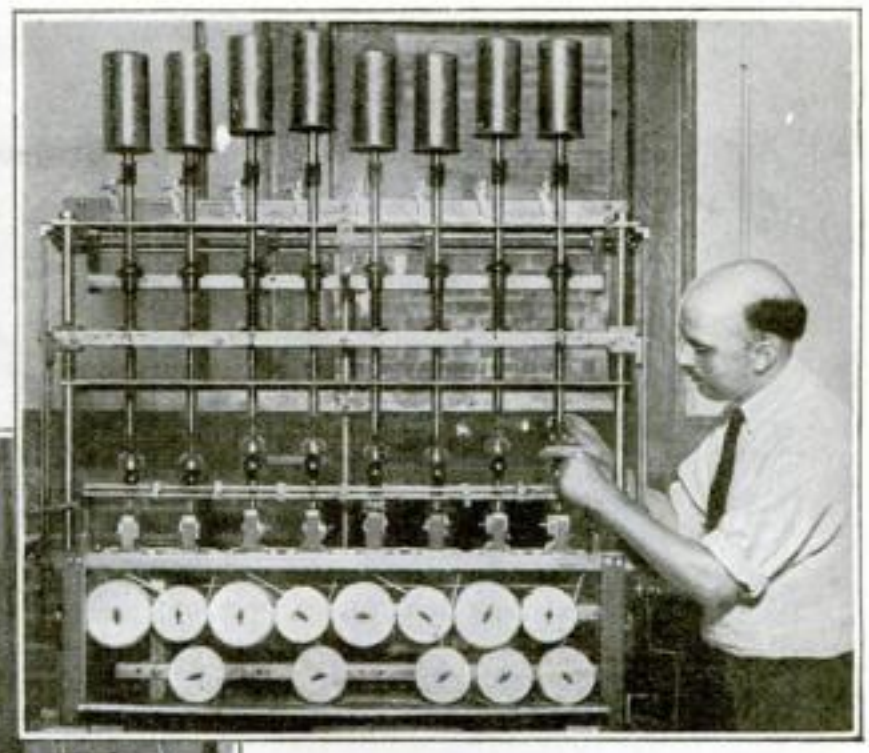
Why Not Weld Them All?

A RECENT little newspaper item, which told of the overhauling of the British ship *Fullagar*, failed to express the interest with which electrical and construction engineers are waiting for complete reports on the condition of the little vessel, which is only 150 feet long. For the *Fullagar* was the first ship in the world to be fastened together entirely by electric welding of the steel plates instead of rivets. Reports indicate that in her eight years at sea, she is in much better shape than most riveted ships after that length of service.

The layman wonders why all steel-frame buildings, bridges, ships, and tanks are not constructed by this noiseless method. One of the reasons is that in many cities the building codes do not permit it; it is too new and untried, the authorities believe, to justify risking the collapse of a skyscraper. Also, many construction engineers and contractors, having riveters available, are reluctant to bother to teach them to use electric welding apparatus or to experiment with men skilled in electric welding but untrained to work on the skeletons of skyscrapers.

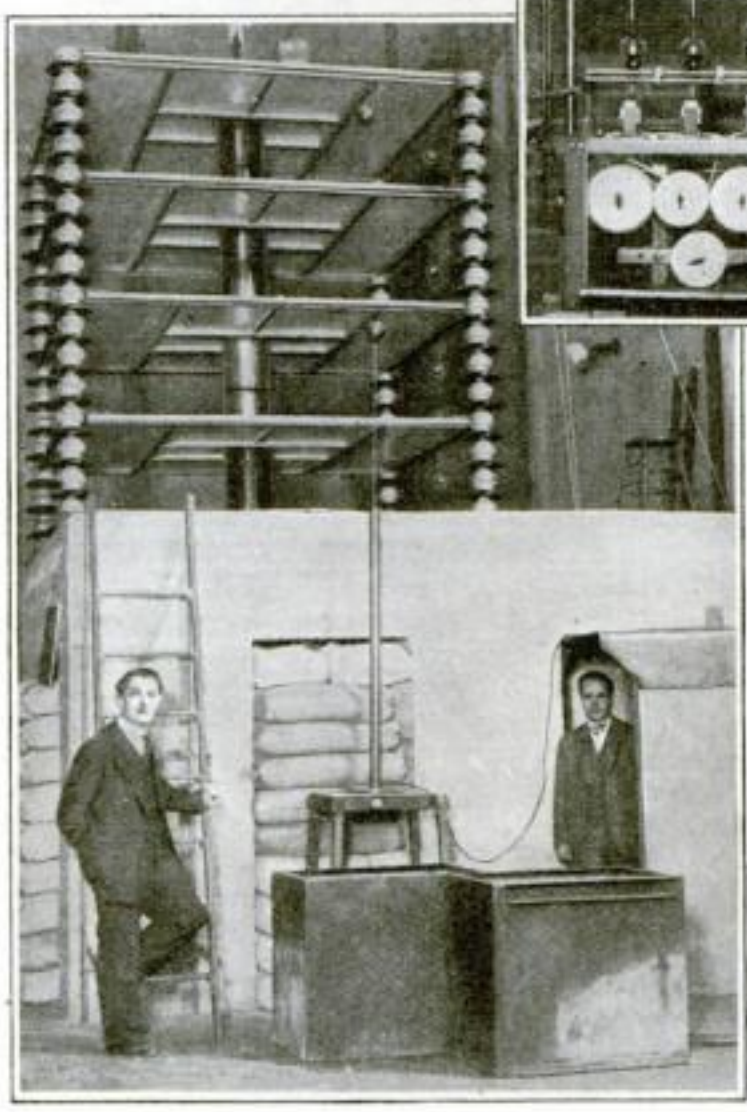
Nevertheless, eighty-five different structures so far have been put together by electric welding in different parts of the world, the largest of them being the fifteen-story steel frame addition to a Detroit department store. Eight bridges and a number of barges and tanks also have been so constructed.

The latest application of electric welding is by the Delaware and Hudson Railroad, which is making its crossties for switches and crossovers out of metal instead of wood, using worn-out rails cut to tie length for this purpose. The cost is less than that of wooden ties and the life much longer. As the railroads of the United States have to replace some 30,000,000 ties a year, it would seem that welded steel ties would be a great economy. On main line tracks, however, metal ties are not practical, interfering with electric signal systems by making a metallic connection between the rails. Efforts are now



Testing with Mechanical Hands

One of the newest testing devices of the U. S. Bureau of Standards, Washington, D. C., is this odd looking machine which measures the accuracy and durability of hand numbering machines used in business offices to number pages and documents. Weighted motor-driven rods push down on the handles of eight numbering machines, whose impressions are recorded on the paper rolls seen below. These impressions show how each machine stands up under the continued pounding, as well as the accuracy with which it prints the numbers.



Study X-Rays Behind Barricade

Piles of sandbags and a concrete wall between operators and machine are used at California Institute of Technology, in Pasadena, to absorb the dangerous offshoots from powerful X-rays generated by 1,000,000 volts of electricity in a fifteen-foot tube, the world's largest apparatus of its kind. The sandbags and wall prevent the rays from injuring Prof. C. C. Lauritson (left), who designed the tube and its protective barricade, and Prof. E. C. Watson, who aids him in operating the machine.

Running Motor Buses on Fuel Oil

J. A. Queeney, vice president of the Philadelphia transit company which is equipping its motor buses to operate on heavy fuel oil in place of gasoline, points here to the new invention which makes it possible. The device is a series of thin metal plates heated by the exhaust. The oil, drawn through the carburetor, passes over the surface of the plates, where it is converted into a dry gas before reaching the cylinders. The fuel, it is claimed, is not only cheaper than gasoline but more efficient.

being made to devise an effective insulating system that will make the use of metal ties feasible on all sorts of railroad tracks.

Benjamin Franklin's Broom

ONE of Benjamin Franklin's contributions to science, heretofore unnoted, was disclosed at the latest annual meeting of the National Broom Manufacturers' Association, where an old diary was quoted, telling how a woman of Franklin's acquaintance had sent him a whisk broom from India and so enabled him to establish the broom-corn as an American farm product. There were some seeds in the wisps of which the broom was made and Franklin, always curious about everything, planted them and distributed their seeds, in turn, to others.

Many plants which we are accustomed to regard as native to America were thus imported, purposely or by accident. Thomas Jefferson introduced the upland rice into the South, as well as many other European crops. The early New England colonists brought their own seeds for planting. Almost the only contributions America has made to the agricultural resources of the rest of the world are the potato, tobacco, and maize or Indian corn. Cotton was brought to America from Africa, and so was the sweet potato. Wheat and all of the other small grains came from Europe. All of our domestic fruits except the cranberry, huckleberry, and possibly the grape, are importations from foreign lands.

Florida's wild oranges started from orange seeds brought by the first Spanish explorers. The wild cattle of the Southwest are all from Spanish stock, similarly brought over in the sixteenth century. Horses were unknown on the American continent until the Spaniards brought them; the Indians had no domestic animals except dogs. All of our domestic fowls except the turkey came from overseas; the turkey is a native 100-percent American.

Tells How Wind Sways Towers

Rocked by a gale blowing seventy miles an hour, this model of a steel water tower will reveal wind pressures and strains to engineers of the U. S. Bureau of Standards at Washington. The model, shown here with Byron H. Monish, a Federal expert on winds, is placed in the Bureau's huge wind tunnel to prove how it can stand up in a gale made to howl around it.

The World's Healthiest "Spuds"

Uncle Sam's plant experts in the U. S. Department of Agriculture have developed a new variety of white potato which, they say, is immune to most of the diseases and blights that prey upon America's tuber crop. Dr. William Stuart exhibits here a few of the world's healthiest "spuds" he helped to grow. "Black rot" holds no terrors for them.

Key to Long Life?

DR. F. G. BANTING, Canadian discoverer of insulin, used in the treatment of diabetes, is going to investigate the life-prolonging possibilities of "royal jelly," the food provided for the queens by worker bees. This substance prolongs the life of the queen bee for several years, and Doctor Banting hopes to discover something that can be used similarly for human beings.

Such medical research is important because more and more people are continuing their activities through advancing years, and eminent physiologists recently have declared that the brain does not grow old but continues to function with increasing power to the end of life.

Old age is a matter of the condition of the body tissues rather than of years, and its onset varies with individuals, according to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, who, in his remarkable experiments, has kept muscles of a chicken's heart alive for nearly twenty years. He told the New York Academy of Medicine recently that the physiological age of any person can be readily determined by examining certain cells from the blood. Tests of this sort may yet be adopted by insurance companies, employers of labor, and others to determine whether a man is actually younger or older than the color of his hair and the date on his birth certificate indicate.

But to whatever limit the efforts of science may prolong human life, the longevity record will continue to be held by lower forms of life. The simpler the structure, the more durable it is. The oldest known living things are colonies of bacteria recently found by Prof. Charles B. Libman, of the University of California, sealed up in rocks which date back to the Algonkian Age, supposed to have been somewhere from one hundred million to two hundred million years ago. The conditions under which these bacteria were found, in rocks brought from hundreds of feet below the surface, preclude the suggestion that they are of later development than the rocks themselves.

These bacteria multiply by division, each individual separating into two parts, which, in turn, divide and continue to do so indefinitely.

What Is the Right Size?

IF A man were sixty feet high he couldn't walk. That is, he couldn't walk without breaking his thigh bones, which will support only about ten times one's weight without breaking. If you multiply one's height, width, and thickness each by ten the total weight will be multiplied by a thousand, but the cross section of each bone is multiplied only by a hundred, so that each bone has to carry ten times as much strain as in the normal individual.

That is the ingenious way in which J. B. S. Haldane, famous English biologist, disposes of the giants of folklore and myth. They couldn't have existed and remained human, he says. If they were shaped differently they wouldn't be human, and they would have had to be shaped differently to have lived.

It is easy to imagine an insect the size of a man, for example, but such insects not only do not exist but cannot exist. Insects absorb oxygen through their skins or shells instead of breathing through lungs. Multiply the mass of a grasshopper by a thousand—that is, make it ten times as large in each dimension—and you have only increased its surface or skin area by a hundred. To support life it will have to absorb oxygen ten times as readily through its skin as it actually does or can.

The surface area of any body does not increase with the increase in the body's weight or mass. A man stepping out of his bath brings with him a film of water of a definite thickness, weighing only about a pound. A mouse falling into a pan of milk is covered with a film of the same thickness, but which weighs almost as much as the mouse itself. Insects getting only part of their body wet are helpless. Watch a fly which has been submerged in water. It cannot fly until it has dried off.

A small animal can fall a hundred feet or more without injury, its bones are so much larger and stronger than those of larger animals, in proportion to its size. The fabulous roc of Arabian myth, the bird which was large enough to pick up a man and fly away with him, could not have existed; it would have had about all it could do to fly away with a lamb,

as the largest condors of the Andes have been known to do. Give a bird a body as big as a man and it would have to have a keel four feet deep on its breastbone to attach the huge muscles which wo .d be needed to flap its enormous wings.

Nature's way of compensating for the disadvantages of being large or small are through changes in the surface or of the breathing and digestive organizations. The larger the animal the more complicated its internal systems. Unless shape changes with size, increase or decrease of size puts an animal out of the running, his species out of existence.

New Wonders in Glass

GLASS is not nearly as leakproof as most of us think, according to Professor G. P. Baxter, Dr. H. W. Starkeweather, and Dr. R. B. Ellestad, of Harvard University. They sealed about a quart of helium gas in a globe of fireproof glass. After a year and a day they found that a little more than one percent of the gas had escaped through the tiny pores of the globe.

Although the Egyptians, more than fifty centuries ago, discovered how to fuse glass by applying heat after mixing common sand chemicals, almost each month new discoveries increase our store of knowledge regarding it. Now it can be made so tough that a bullet from a forty-five-caliber pistol, shot from a distance of ten feet, will glance off. It can be made so that it will bounce, bend, pour like water, even be sawed like wood.

Austrian scientists have perfected a way to make it flexible. Glass wool, a fluffy stuff that looks and feels like silk, is ordinary glass spun into threads so fine that it would take 2,800 of them laid side by side to make a one-inch ribbon!

Glass really is an oxide of a metal and is commonly made from a fusion of oxide of silicon with another metallic oxide, such as the oxides of boron, soda, or iron. Such is the magic of glass that to begin to list even the most common necessities it supplies would be an endless task. Without it we could have no incandescent lamps, radio tubes, nor many other wonders of modern science.

Radio's Puzzles

THE United States Bureau of Standards recently announced that radio engineers confess being baffled by the problem of static. Behind that announcement lurks opportunity. The inventor of the really effective static eliminator can become a multi-millionaire.

What is static? The lower portion of the atmosphere, which we call the air, and in which our radio broadcasting is done, is a gas. It consists of molecules and atoms of various elements suspended in a great mixture. So long as it is quiet and free of water, it has hardly any electrical effect. But when other influences begin to stir it up, many of the atoms become ionized, which means that they are split up into electrical particles. These conditions prevail most of the time without interfering with your radio reception. It is when the ionization is localized and sporadic, as for example when a thunderstorm is brewing, that the notes of the sweetest sopranos are drowned and the most persistent lecturers choked off.

Static, however, is not the only unsolved radio problem. Engineers throughout the world are trying to find the answers to many other questions. They don't know whether transmission from east to west differs from that in the opposite direction; whether there is a wave length limit beyond which transmission over land is virtually identical with that across water; whether waves above a certain frequency fail to return to the surface of the earth.

Radio, though it talks a lot, is still in its early infancy. Improvements aplenty are to come, and each one of them will mean a fortune for its inventor! Another problem is fading. Why do signals come in strong, then fade away periodically? Many fine-spun theories have been advanced, but no proof or remedy.

Bolt of Iron Cast from the Sky

Australian kangaroo hunters stumbled upon this 1,400-pound meteorite which had plunged from the sky in the vicinity of Queensland. Brought to America and analyzed, it was found to contain ninety-three percent iron, some nickel and platinum, and particles of other minerals. Dr. Oliver C. Farrington (left), curator of geology for the Field Museum in Chicago, is shown here with an assistant, studying the huge meteorite.

Why Sap Rises

THE mystery of the rise of sap which has puzzled scientists for years apparently has been solved. Dr. D. T. Macdougal, of the Desert Laboratory, Tucson, Ariz., recently announced his discovery that the sap is hoisted by the leaves to the tree top from above, not pushed up by the roots, as experts long believed.

And this can happen, he explained, because water, strangely, is as strong and "unbreakable" as manila rope or some metals. The leaves of the tree evaporate water. A tension is created at the top of the sap tubes in the leaves. An "unbreakable" column of water is pulled up from the ground through the roots and the trunk by way of a complicated network of tubes and passages.

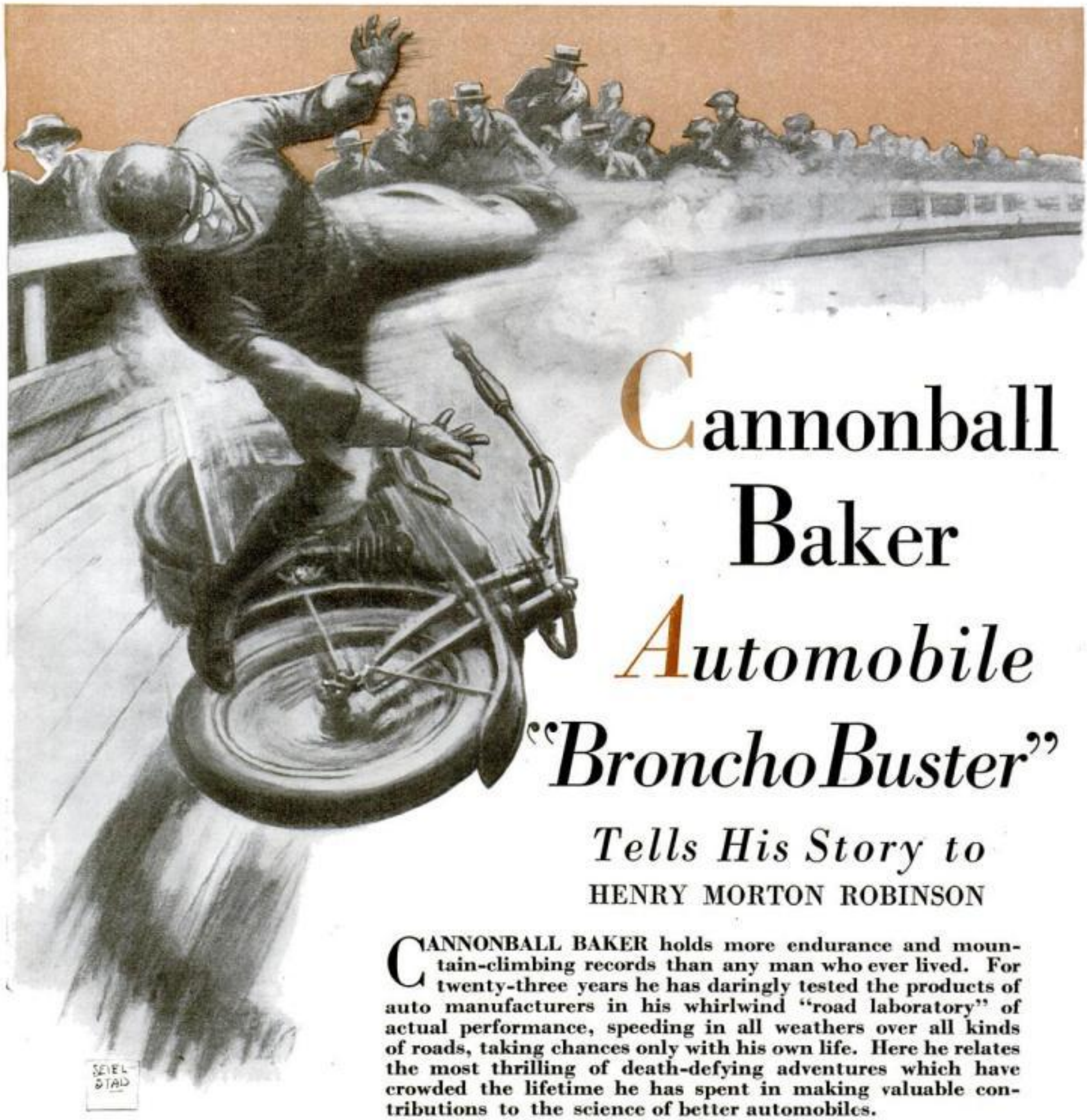
To understand the strength of this column of water, fill a small glass tube with water absolutely free from air bubbles. It takes a pull of more than a ton to the square inch to tear such a water column apart. Water, by this test, is about as strong as manila rope, which requires a pull of about a ton and a half to the square inch to break it. It is so strong that it sticks together with more than ten times the tenacity of Portland cement!

Imagine the columns of sap that fill a tree's tubes as so many metal wires. When the top is pulled the wires are hauled up. This an ingenious machine called a "dendograph" proves by measuring the girth of the tree trunk. During the day, when the sap is rising, the trunk shrinks, due to the pull. At night it swells as the tension is released. If the sap were pushed up instead of being hoisted, the opposite would be true.

Until recently scientists have believed that force pumps of some kind in the tree's roots raised the sap. Now it appears that the true explanation has been found.

Fresh "Milk" Right from the Bark

"Cow trees" recently discovered in the Puerto Barrios district of Guatemala by Prof. Samuel J. Record, Yale University forestry expert, give milk that looks and tastes like the familiar dairy product and is said to be highly nutritious. This picture shows how natives "milk" the trees by gashing the bark. They use the "milk" in coffee.



Cannonball Baker *Automobile "BronchoBuster" Tells His Story to*

HENRY MORTON ROBINSON

CANNONBALL BAKER holds more endurance and mountain-climbing records than any man who ever lived. For twenty-three years he has daringly tested the products of auto manufacturers in his whirlwind "road laboratory" of actual performance, speeding in all weathers over all kinds of roads, taking chances only with his own life. Here he relates the most thrilling of death-defying adventures which have crowded the lifetime he has spent in making valuable contributions to the science of better automobiles.

I'VE charioted across North America exactly ninety-three times! The first time with twenty-eight blowouts and three breakdowns. The last time with not a single tire change or mechanical adjustment of any kind. When you stop to think about it, that's just about the history of automobile and motorcycle development in this country. My mounts have ranged from the sputtering one-cylinder motorbike with which I made my first transcontinental run in 1911, to the mighty 110-horsepower sportster of 1928. For the past twenty-three years I've pushed all makes and models over desert trails, mountain passes, and gully bottoms—taking everything that came in the day's run. And it was a pretty tough run, too.

I grew up in a racing town. Indianapolis, the city that made automobile road-racing famous, was just beginning to hold its speed tournaments when I lived there as a kid. One of my earliest memories is squeezing in at the wind-up of a road classic, in which Harry Payne Whitney, the winner, had recorded an average of 43 miles an hour. Second prize went to a youngster named Barney Oldfield, who came roaring home at the terrific speed of 42.6 miles. Anything better than a mile in 2.20 seemed a breakneck pace in those days.

The bicycle craze was at its height just then, and naturally I had a wheel—an old Pope-Hartford. Until I was sixteen years old I was satisfied to pedal around with my own leg-power. But when I went to work in a machine shop a year later, I saved enough money to buy a portable motor, rated at three-quarter horsepower, and attached the contrivance to my "ice wagon." The effect was dizzying! On a trial spin, I passed a fire engine going nineteen miles an hour, and began to regard myself as the coming race driver of the U. S. Sometime later I secured a secondhand Indian, tinkered around with it till I got it up to thirty an hour, and began looking around for an opportunity to break into the motorcycle racing game.

My chance broke with dramatic suddenness. A traveling fair came to town when I was about nineteen, and I heard there was to be a motorcycle race on the old trotting track. With some vague notion of entering my one-lung Indian, I strolled down to the grounds and found the Big Boss in a steaming rage.

Illustrated by B. G. Seielstad

"A vicious blow-out twisted the handlebars out of my grip, my machine whizzed from under me, and I was catapulted through the air, landing in the middle of the track."

"Run over to the local garage," he was shouting at a stake-man, "and see if they've got anyone that can ride a motorcycle. 'Red' Nelson's off on another jag, and we haven't anyone to take his place in the exhibition race."

My career as a racing driver dates from that moment. I stepped out onto the track and announced myself. "I'm pretty good on a motorcycle," I began.

"Ever work with a twin-cylinder Indian?" he asked, surveying my lanky six-feet-two.

"Sure," I lied. "I've been repairing an Indian for two years." (Which was true.)

"Then warm up that machine and stand by for action."

I lugged the red monster out onto the track, and for the first three laps I almost collapsed from heart failure. The old bike had a handlebar throttle, the first one I'd ever seen, and when I went around corners I'd unknowingly twist the throttle wide open in my attempt to stay on the track. From the grandstand the effect must have been wonderful—but to this day I don't know why I didn't kill myself going around those corners. When I finally brought the old boat to a halt, the Circus Boss wiped a moist brow and asked me my name.

"Erwin Baker," I replied.

"Erwin me eye," he flared. "No guy that drives like that should be called Erwin. From now on your name is Cannonball, and your pay is eighteen a week."

The name stuck, although I've had a couple of raises in pay since then. Well, I worked with that circus all summer, racing around the dirt tracks throughout the Middle West. I managed to save about $150—and you can guess what I

Cannonball at the wheel. The auto, he says, is the safest, most convenient, method of travel man will ever know.

bought with my savings. Right! A brand-new motorcycle, bright red, and guaranteed to deliver eighty miles an hour. When I got through tuning it up, there wasn't a bike on the dirt-track circuit that could outrun that streak of red paint.

My next couple of years were spent in breaking track records at various state fairs. I've never figured up how many local records I broke, but it's way up in the hundreds. It was a tough racket, but I gained a helmetful of experience. Some of those experiences were wildly hazardous, involving the loss of limbs, machine, and once or twice the lives of close associates.

One day a chap named Bob Perry and I were meeting some local boys in a twenty-five-mile exhibition race at Rockford, Ill. I was out in front, leading my team mate Perry by about fifty yards; the rest of the pack was half a lap behind. A vicious blow-out twisted the handlebars out of my grip, my machine whizzed from under me, and I was catapulted in a semicircle through the air, landing flat on my back in the middle of the track. My instinct was to get up and crawl off the track. But a secondary reaction told me that old Perry would come thundering past in a split second, and that the slightest movement on my part would confuse matters fatally. So I lay motionless on my back, looking up at the deep blue sky for three eternities. Perry, by adroit steering and lightning headwork, veered his machine away from my head and midriff—but couldn't avoid my ankles. He shot across my shins going like a motor-driven bullet. As soon as he was past, I rolled over and over till I reached the edge of the track, and sat up in time to see Bob slide across the finish line an easy winner. I made him buy me a quart of liniment with his prize money—and he said he was glad he didn't have to spend the money on flowers.

"Erwin me eye," flared the Big Boss. "From now on your name is Cannonball, and your pay is eighteen a week."

I soon began to notice something about my motorcycle brethren. They could go just as fast as I could, and were every bit as nervy — but somehow they didn't seem to have my *endurance*. I discovered that I could ride for twenty-four hours a day, and feel as fit at the finish as at the send-off. This quality of endurance had no particular value in the twenty-five-mile races, but when the motorcycles began to improve, and we were asked by manufacturers to shoot at long-distance marks, I realized I could sit astride a bike just a bit longer than the other fellow. In 1916 I determined to give my staying powers a thorough test. So I entered in the twenty-four-hour grind at Cincinnati, Ohio, where they were holding out a big stake to anyone who could break the track record for distance.

We started off at eight A.M., and for sixteen hours I clicked off better than sixty-five an (Continued on page 164)

Cannonball is proudest of his latest feat of crossing the continent in three days, then turning around and recrossing it.

Are You in the Right Job?

Psychologists Prepare a Series of Questions That Will Help You Get a Line on Yourself

By RUTH MOORE MORRISS

ARE you happy in your job, or do you chafe under the drudgery of your daily tasks?

Do you know whether you are doing the kind of work for which you are best fitted?

Science has just reduced to a minimum the guesswork in answering these questions. Using a test perfected after years of psychological research, you now can pick the right job for yourself with scientific accuracy!

The new occupational guide, which by special arrangement with the men who devised it I present below, is the work of Dr. John J. Morgan, Dr. C. A. Neymann, and K. D. Kohlstedt, of Northwestern University, Evanston, Ill.

Humanity, broadly speaking, is divided into two major psychological groups—the extroverts and the introverts. Reducing this distinction to its simplest terms, an extrovert is a mixer, a "go-getter." An introvert is a dreamer, a creator.

More specifically, an extrovert is a person who is open to suggestion, free of self-consciousness, friendly toward people and dependent upon them, and whose success depends upon being in a position where he meets people and works with them. For those reasons, most diplomats, orators, and salesmen are extroverts. Pronounced examples, according to the Northwestern psychologists, are the late Theodore Roosevelt, Mussolini, Alfred E. Smith, and Chief Justice William H. Taft.

The introvert, on the other hand, does not depend for his success upon contact with other people. He makes up his own mind and then knows exactly what to do. Hence he makes a good executive or keen analyst, but a poor salesman; a fine research worker or scientist, but a mediocre social service agent; an inventor, editor, or composer; but not a promoter, reporter, or orchestra conductor. Outstanding examples of the introvert class are the late President Wilson, Colonel Lindbergh, Calvin Coolidge, and Herbert Hoover.

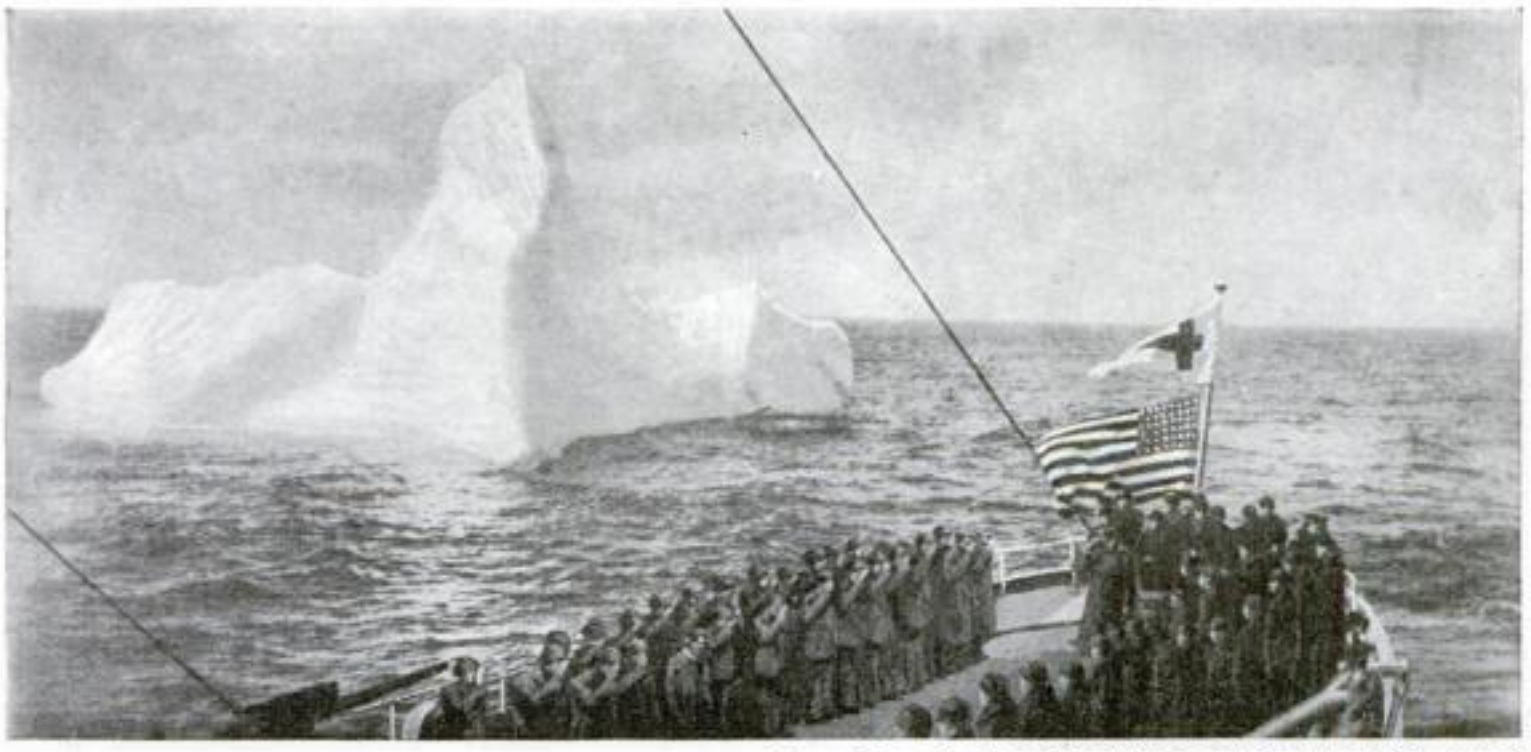
The Neymann-Kohlstedt test enables you to size up your own case, to diagnose your own character and personality. You need only answer honestly the series of fifty questions on this page, then judge yourself by comparing your answers with those on page 144. If your answers agree with those printed there, you are a pronounced extrovert. But most people are not 100 percent extroverts or introverts.

Therefore, if twenty-eight of your answers or more agree with those of the sample, it is sufficient to indicate that your tendencies are extrovertal. If twenty-eight or more are in disagreement, your tendencies are introvertal.

Application of the new test to the problem of employment in business and industry will, in the opinion of leading psychologists, result in saving millions of dollars now wasted in people unsuitably employed and in labor turnovers.

THIS test is composed of fifty statements, each being followed by the words "Yes" and "No." There is no implication of right or wrong in any of the statements and you are asked to consider them from the viewpoint of personal like or dislike. Read the first statement and if you like the idea that it expresses draw a line under *Yes*. If you dislike it draw a line under *No*. Proceed in the same way with the rest of the statements. After you have finished turn to page 144 and judge your temperament and ability by comparing your answers with those printed there.

1.	Be by yourself a great deal.	Yes	No
2.	Think of life in terms of pleasure.	Yes	No
3.	Always be calm and collected.	Yes	No
4.	Have a great deal of confidence in others.	Yes	No
5.	Think or dream of what you will do five years from now.	Yes	No
6.	Stay at home during a social affair.	Yes	No
7.	Work with many people around you.	Yes	No
8.	Do the same kind of work all the time.	Yes	No
9.	Enjoy social gatherings just to be with people.	Yes	No
10.	Think a great deal before deciding anything.	Yes	No
11.	Accept suggestions rather than working them out for yourself.	Yes	No
12.	Quiet rather than exciting amusements.	Yes	No
13.	Dislike having people watch you.	Yes	No
14.	Quit a tiresome task.	Yes	No
15.	Save money rather than spend it.	Yes	No
16.	Seldom analyze your thoughts or motives.	Yes	No
17.	Indulge in reverie (daydream) or thought.	Yes	No
18.	Have people watch you do things that you do very well.	Yes	No
19.	Let yourself go when angry.	Yes	No
20.	Work better when people praise you.	Yes	No
21.	Have excitement.	Yes	No
22.	Be a leader at a social affair.	Yes	No
23.	Speak in public.	Yes	No
24.	Do the things that you dream about (daydream).	Yes	No
25.	Rewrite social letters.	Yes	No
26.	Get things done very quickly rather than being slow but sure in movement.	Yes	No
27.	Think a great deal.	Yes	No
28.	Be able to express your keenest feelings (joy, sorrow, anger, etc).	Yes	No
29.	Seldom pay attention to details.	Yes	No
30.	Be exceedingly careful in meeting people.	Yes	No
31.	Seldom think about yourself.	Yes	No
32.	Puzzles.	Yes	No
33.	Act on suggestions quickly rather than stopping to think.	Yes	No
34.	Read about rather than do a thing.	Yes	No
35.	Enjoy the story more than the way it is written.	Yes	No
36.	Keep a personal diary.	Yes	No
37.	Keep quiet when out in company.	Yes	No
38.	Act on the spur of the moment.	Yes	No
39.	Have nothing to do with people holding views opposed to your own.	Yes	No
40.	Dislike thinking about yourself.	Yes	No
41.	Seldom change an opinion already formed.	Yes	No
42.	Change from one type of work to another frequently.	Yes	No
43.	Avoid trouble rather than face it.	Yes	No
44.	Believe that rumors are important.	Yes	No
45.	Confide in others.	Yes	No
46.	Distrust people you have just met until you get better acquainted.	Yes	No
47.	Study others rather than self.	Yes	No
48.	Spend your vacation at some quiet place rather than at a lively resort.	Yes	No
49.	Seldom plan out work before you begin it.	Yes	No
50.	Take part in conversations going on near you.	Yes	No



Memorial service aboard the U. S. ice patrol cutter *Modoc* over the spot where the *Titanic* collided with an iceberg and sank with 1,503 souls in 1912.

Slaying the Ice Monsters

Frozen Giants Blasted to Bits—How U. S. Patrol Boats Trail Atlantic "Growlers" and Guard Ships from Peril

By MICHEL MOK

"FOUR bergs in sight in a radius of seven miles. Fog getting dense. Danger to westbound traffic. Sixty growlers northeast Cape Race."

Here is a message typical of the radio flashes that are now being received daily by the U. S. Hydrographic Office at Washington, D. C., from the International Ice Patrol. They tell the thrilling story of a bloodless war that is being waged by our Coast Guard upon one of the brute, destructive forces of Nature.

The annual ice crusade is on!

Two sturdy little cutters of the U. S. Coast Guard, the *Tampa* and the *Modoc*, constituting the patrol, left their base at Halifax a few weeks ago. Straight north they steamed into the home of the white monsters that threaten vessels. It is their perilous task to track the icebergs which, each spring, break from the Greenland ice cap and swing down into the steamship lanes, and to make them harmless to vessels that ply the North Atlantic.

The *Tampa* and the *Modoc* keep day-and-night vigil until June, when the danger to shipping will be past. For the cutters it is a period of unbroken action—dogging the trail of the mobile marble towers until they melt, and sending shipmasters of many nationalities warnings that enable them to steer clear of the giant peaks, and so avoid disastrous collisions such as that which sank the *Titanic* with 1,503 souls on her maiden voyage in 1912.

Time was when the cutters attacked the bergs with TNT, other high explosives, and even gunfire. But this method proved so ineffectual in the fight against the mountains of ice that it has virtually been abandoned.

Spectacular explosion of ice cake, blown to bits by intense heat—5,000 degrees F.—generated by thermit.

Preparing to shatter a small iceberg with thermit. Men wearing life belts scale the berg to place the charges at the center.

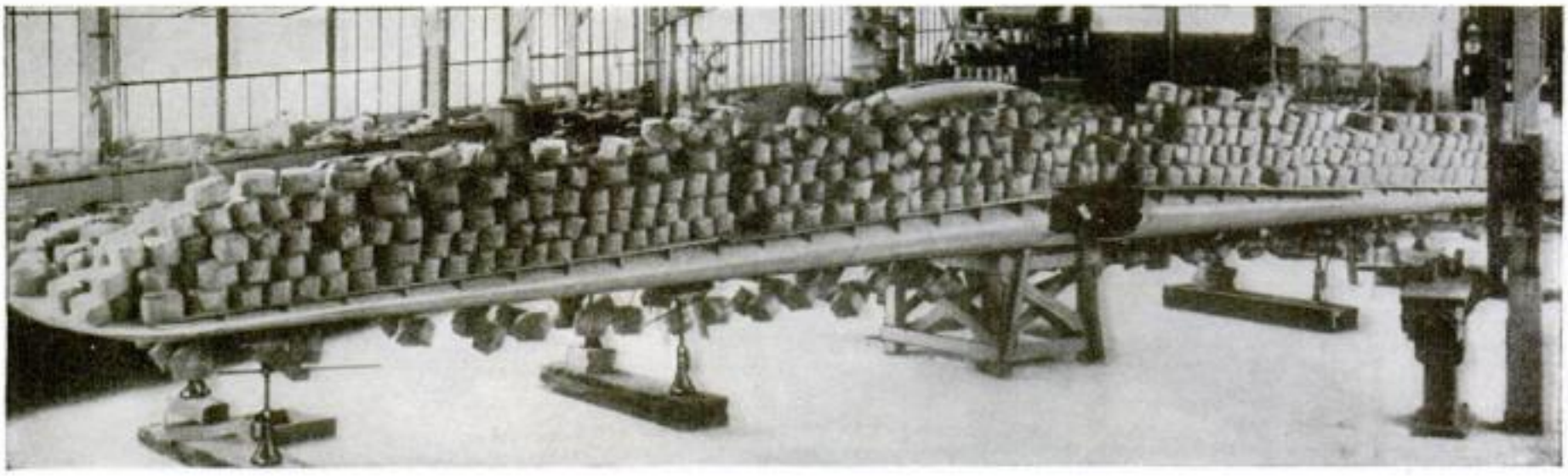
Courtesy Prof. H. T. Barnes

But while the *Modoc* and the *Tampa* were making ready for this year's cruise, Dr. Howard T. Barnes, noted engineer of McGill University, Montreal, Canada, was engaged in actual battle with ice jams in the St. Lawrence River. Accompanied by a small party of assistants, Professor Barnes burned hundreds of thousands of tons of ice out of the stream by the thermit process, perfected by him after years of experiment. This method makes use of the intense heat produced by firing a mixture of fine aluminum filings and iron oxide.

With the judicious use of thermit, Dr. Barnes claims, icebergs may be destroyed before they become a menace to Atlantic shipping. A couple of years ago, off the Newfoundland coast, he blew three icebergs to fragments. Now the Canadian government has invited him to clear the St. Lawrence and obviate a repetition of the disastrous floods of last spring, when ice from Lakes St. Louis and St. Francis drifted down and piled up in a jam in the river below Montreal.

Not in itself an explosive, thermit, when set off with a time fuse, quickly develops terrific heat, reaching a maximum of 5,000

(Continued on page 142)



Wing Strength Tested by Piles of Sandbags

LOOPING-THE-LOOP and topsy-turvy flying cause strains that are mild compared with those to which wings are subjected in an airplane factory at Burbank, California.

Before new wings are attached to the streamline fuselage of this make of machine, they are loaded with several hundred sandbags while testing engineers watch their strain-recording instruments. After the sandbags are removed, the wings are gone over carefully to see if the stringent test has revealed any weaknesses.

Planes of this type were used last year by Art Goebel on his record-breaking cross-continent flight, and by Wilkins and Eielson on their trip over the top of the world from Alaska to Spitsbergen, and also for a series of flights in the Antarctic regions which these explorers have made more recently.

How Starlight Is Measured by Photo-Electric Cell

THE light of stars is measured by photo-electric cells. Dr. Joel Stebbins, of Washburn Observatory, Madison, Wis., recently explained that a photo-electric cell is an electric lamp which works backward; in an ordinary bulb you put in current and take out light, while in the photo-electric cell you put in light and get a current dependent in intensity upon the strength of the light.

A star image is focused upon a delicate photo-electric cell by the telescope and the resulting current measured by a galvanometer.

Planes Glide into River Like Ducks

A FREIGHT car float, several hundred feet long and sixty feet wide, has been turned into a unique runway for amphibian planes by the Loening Aeronautical Engineering Co., of New York City.

One end of the float is attached to the bank of the East River. The other, by means of bulkheads filled with water, is lowered several feet below the surface of the water. The machines land upon the river, taxi to the float, lower their wheels, and run up on dry land to discharge or take on passengers and cargo. When they are ready to leave, the planes roll down the runway into the water as ducks wade into a pond before swimming away.

The runway eliminates the inconvenience and danger of transferring passengers between the plane and a launch or rowboat when starting or ending a flight. The rise and fall of the tide does not interfere with the operation of the device, because it is attached at only one end.

One of the first to use the new runway was Col. Charles A. Lindbergh. Similar runways for amphibian planes are expected to be established as part of the airport equipment of municipally-owned fields bordering on rivers or other large bodies of water.

Tests Breath of Honeybees

BY ANALYZING the breath of the honeybee, Prof. G. H. Vansell, of the University of California, discovered that in winter, when the hive is at rest, the bees absorb moisture from the air, while in summer, when they are working, they give off twenty-five times as much moisture in breathing. He suggested that this gave a possible index to the health of the hive, thus bringing scientific research to the aid of the beekeeper in the fight against destructive diseases.

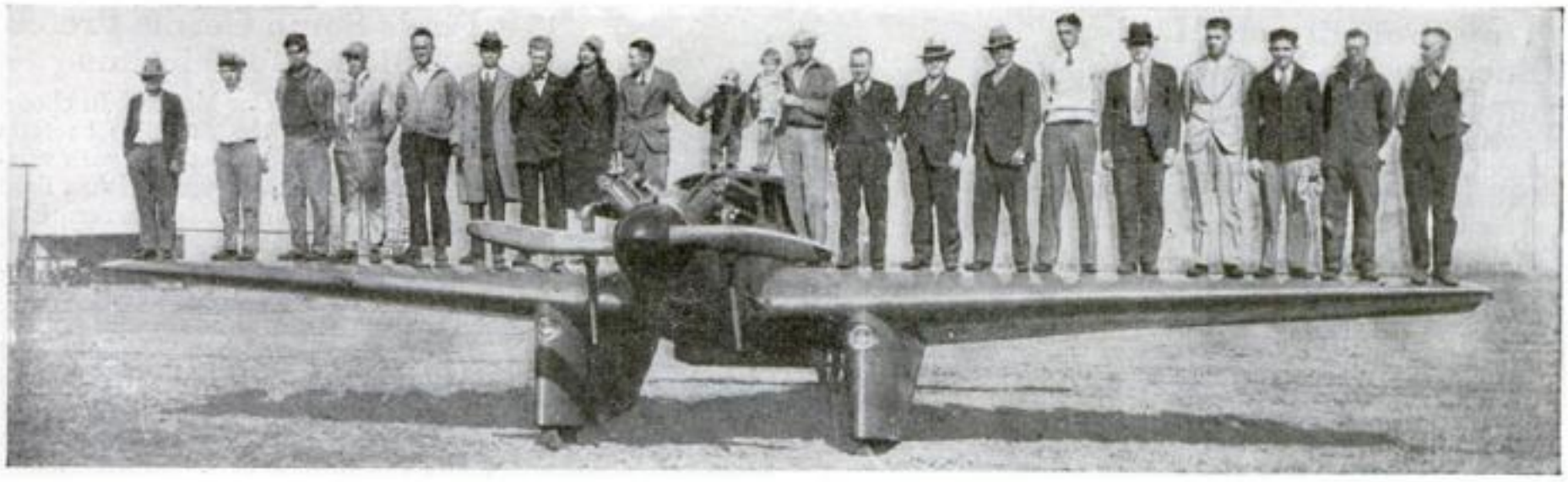
Lindbergh's Trophies Fill Wing of Memorial

TROPHIES filling the entire west wing of the Jefferson Memorial in St. Louis, Mo., prove the world's esteem for Col. Charles A. Lindbergh.

During his tours of Europe and Latin America after his spectacular crossing of the Atlantic Ocean in May, 1927, medals and plaques, pictures and loving cups were showered upon him.

One of the latest additions to the collection is the Harmon Trophy, presented by the International League of Aviators during the International Civil Aeronautical Conference at Washington, D. C., which marked the twenty-fifth anniversary of man's conquest of the air.

A flying boat sliding into the water from launching way devised from a freight car float. The runway is used also in discharging passengers and cargo.



Sturdy Monoplane Wears Streamlined "Pants"

AN AIRPLANE that wears "pants" is the latest development in streamlined aircraft. Both wheels of the forward landing gear, and the struts supporting them, are incased in streamlined "trouser legs" to reduce head resistance. Lights are provided at the top of each "leg" to aid in maneuvering the plane to a landing at night.

The cabin, motor mounting, and even the exhaust pipes are designed to slip through the air with the least possible resistance. As a result, the monoplane, known as the "Scout," is said to have given a remarkable performance at its initial trial in Los Angeles recently. It whizzed through the air at 200 miles an hour at an altitude of 1,000 feet, yet landed at only one fifth that speed, drifting down to the airport at the comparatively slow speed of forty miles an hour.

It also is asserted that the plane cannot go into a tail spin. The wings, with a spread of thirty-five feet, are internally braced and placed low. They are made of plywood. As a proof of their strength, the designer allowed nineteen adults and two children to stand in a line on top of them as pictured above. Under this weight the wings remained rigid.

The designer of the plane is M. C. Tunison, formerly an aeronautical engineer for the Government.

Tractor Tows Out Giant 12-Passenger Plane

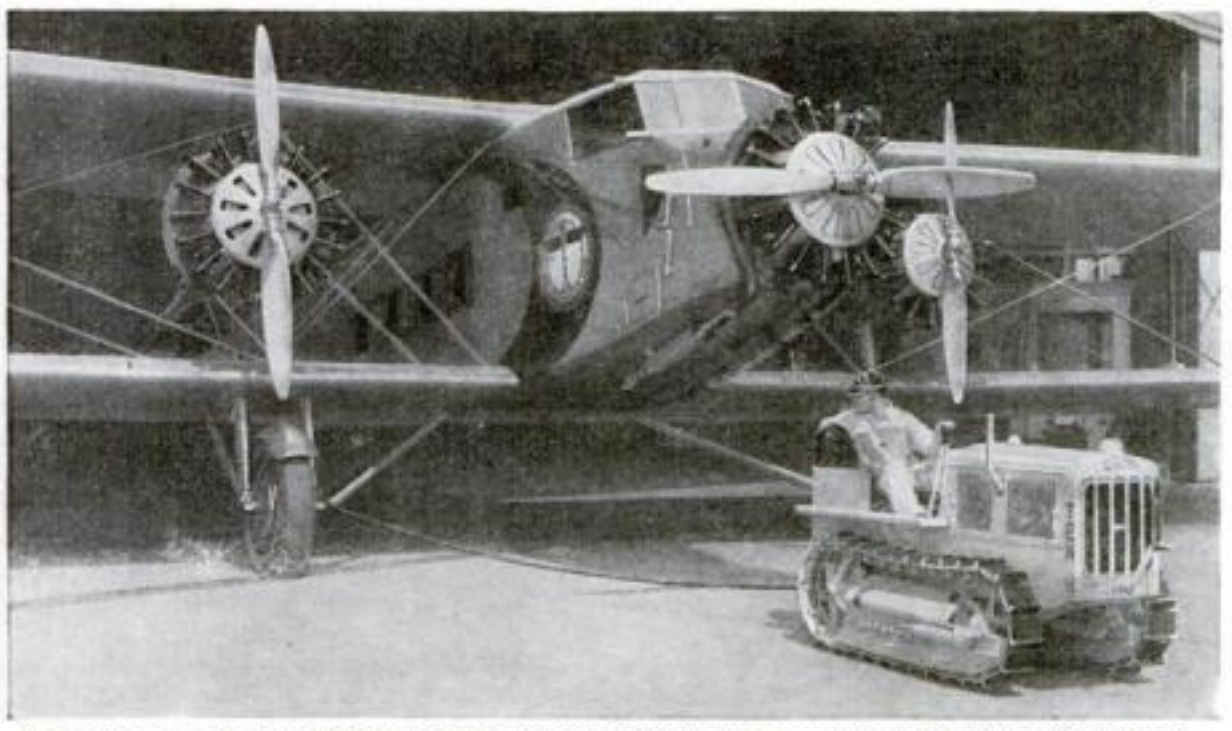
LIKE a tiny ant dragging a large butterfly along the ground is the small tractor which hauls a new big air liner to the starting point at the Oakland Municipal Airport, Oakland, Calif. This new twelve-passenger biplane recently took off on its first flight on a regular Oakland-Chicago air service. It follows an almost direct line east and west on its runs to and from Chicago.

The new plane, one of the largest ever put into passenger service in America, is driven by three powerful motors, and is equipped with steel propellers. The unusual width of the landing gear can be noted by comparing it with the size of the man and tractor in front of the plane.

Test "Cast Stone" Strength With Tiny Cylinders

IN LITTLE cylinders, two inches long and two inches in diameter, "cast stone," the new building material recently described in POPULAR SCIENCE MONTHLY, is being tested at the Bureau of Standards, Washington, D. C. Its average compressive strength was discovered to be 6,250 pounds a square inch.

Other tests of the unique artificial "stone" will be conducted shortly to determine its freezing resistance and water absorption characteristics, so builders may have definite knowledge of how the material will act under given conditions.



Tractor towing the giant Boeing air liner, which carries twelve passengers on Oakland-Chicago trips. The great size of the "Pullman of the Sky" is apparent when compared with the tractor in front of it.

R-100 Passengers to Land on 270-Foot Mast

TWO hundred and seventy feet above ground, passengers on the British dirigible *R-100* will step from the airship to the landing platform of a mooring mast recently completed at Montreal, Canada, to serve as a terminus for the sky liner on its maiden voyage from England this year. The huge rigid gas bag, as large as the steamship *Mauretania*, is to be moored by its nose to the top of the mast so it can swing about with changes in the direction of the wind.

A gangplank, pushed out from the cabin passageway, will transfer passengers to the tower's platform. Elevators will facilitate the unloading and loading of passengers and baggage when the sky liner arrives and departs. The new arrangement is expected to simplify the "docking" of the airship.

When the *Graf Zeppelin* arrived at Lakehurst, N. J., last fall, much time was consumed in bringing the airship to rest near the ground, so the passengers could descend on short ladders, and in attaching it to the stub mast used to moor it. Designers of the Montreal mast believe their design has solved many of the landing problems of rigid airships.

Tiny Propeller on Man's Back Pushes Him Uphill

THE latest invention of the Brazilian aviation pioneer, Alberto Santos-Dumont, is a tiny air-cooled motor and propeller which, strapped to a man's back, pushes him uphill on skis, thus saving his energy while engaging in the sport. The single-cylinder motor, complete with gasoline tank, propeller, and framework, weighs but three pounds. The inventor has named the device an "ornithonico."

Aided by Rio de Janeiro's mayor, he recently demonstrated it before crowds which thronged that Brazilian city at a celebration in his honor when he returned from France. Santos-Dumont, the man wearing a dark suit and standing in the center in the photograph, was a pioneer in aviation. In 1906, he made a hop of several hundred feet near Paris, France, in a biplane modeled after a box kite.

His earliest air fame came from exploits with dirigible balloons, which he began constructing in France in 1898. He won international recognition by capturing the Deutsch Prize of $50,000, in 1901, by flying from St. Cloud to the Eiffel Tower and return in one of his gas bags in less than half an hour. While Santos-Dumont was born in Brazil, he has lived for long periods in France, where all of his flying experiments were conducted.

Santos-Dumont (center) and man-propeller.

Motor Boat Leaps Through a Hoop

DASHING over the water at thirty-five miles an hour, a tiny hydroplane, the *Oh Kay*, its outboard motor racing at full speed, shot up a greased slide, tore through a paper hoop, and leaped forty feet when it recently inaugurated a nerve-tingling sport on Lake Elsinore, Calif. The pilot, Floyd Pierce, estimated the craft was eight feet above water at the height of its jump.

The boat used in the gruelling test was one of the victorious entrants in the outboard division of the Detroit Regatta last fall. A jumping contest was added to the program of the midwinter races on Lake Elsinore after the *Oh Kay* had shown it could withstand the strain of the thrilling exhibition.

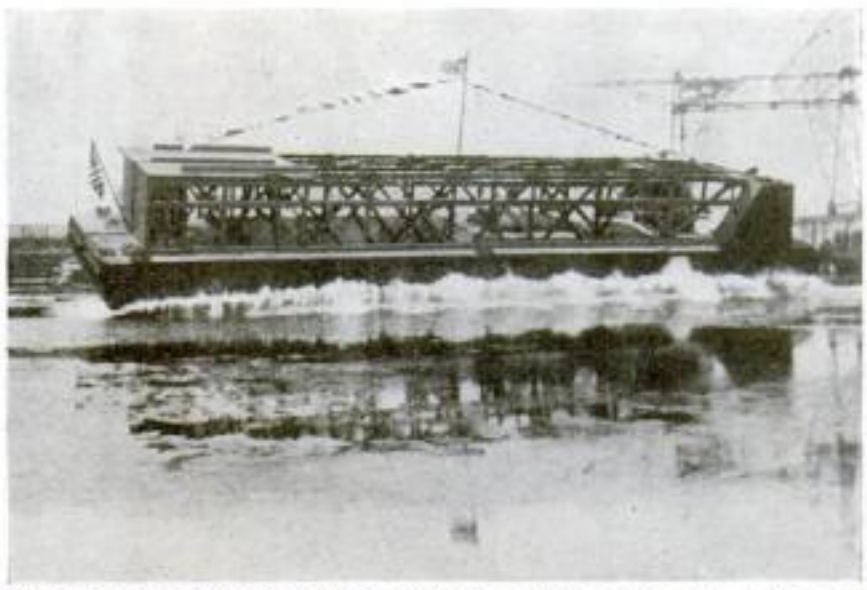
Great skill is required to maintain the balance of the little boats during the leap so they will strike the water on an even keel. This was made more difficult in Pierce's first jump because a piece of paper from the hoop caught on his head, as can be noted in the picture. In spite of the fact that he was momentarily blinded, he landed safely.

Floyd Pierce jumps motor boat through hoop.

New Dredge Driven by Diesel Motors

SLIDING off the ways at Manitowoc, Wis., the first of a series of unique dipper dredges, designed for Great Lakes service, struck the water of Lake Michigan recently and was started on the journey to the scene of its first operations.

The new type dredge is of all-steel construction and the dipping machinery is operated by electricity generated on board. Powerful Diesel motors, using heavy oil, cheaper than gasoline, operate generators which furnish the current.



New steel dipper dredge sliding off ways at Manitowoc, Wis., into Lake Michigan. Diesel engines operate machinery on board this unique craft.

Finds Some Germs Prefer Blonds for Victims

GERMS also prefer blonds. In choosing a victim, the chainlike bacteria streptococci, which infect man with various diseases, pick a person with a light skin rather than one with dark, according to Dr. Samuel J. Holmes, of the Department of Zoology, University of California. The germs make their entrance to the body through the outer skin.

Studies of mortality tables show that the diseases caused by such germs are less frequent among negroes than among whites, Dr. Holmes reports. He believes that the pigment in dark skin is not a protection, except against light rays, but that the production of pigment possibly is an index to a vital resistance to the sort of infection produced by the streptococci.

Pinpoint Device Registers Heat from Far Suns

AN INSTRUMENT so small it would take a thousand to equal the size of a drop of water was used recently by Dr. Edison Pettit and Dr. Seth Nicholson, at Mt. Wilson Observatory, to measure the heat of stars billions of miles away (This device was constructed under a microscope.

It is a thermocouple and will register variations in heat as slight as one hundred thousandths of a degree. Used in connection with the 100-inch Hooker telescope at the Mt. Wilson Observatory, the sensitive instrument recorded the heat coming from 124 stars. Betelgeuse, a flaming sun 27,000,000 times as big as our sun, raised the temperature of the receiving instrument only one sixtieth of a degree centigrade, so far away is it.

The heat radiations measured by the thermocouple showed certain stars to be larger than indicated by the Michelson inferometer, previously used for such measurements.

Use Poison Gas to Rout Foes of Pineapples

A POISON gas offensive is being waged by pineapple growers in the Hawaiian Islands against the nematode, a worm pest that attacks the roots of both pineapples and sugar cane, destroying from fifty to ninety percent of the crop. Multiplying rapidly, the plant enemies have increased tremendously in recent years.

The planters tried to halt the inroads of nematodes with potassium cyanide, carbon bisulphate, and chlorine, but none of these poisons proved effective. After two years of research, chemists of the U. S. Army stationed in the islands suggested the powerful toxic gas, chloropicrin, as a means of fighting the worms. Tests have been conducted with remarkable success.

The deadly gas not only exterminates the pests, but appears to stimulate the growth of the plants as well.

Gilded Auto of 1903 Still Runs in Fine Style

TWENTY-FIVE years old and still going strong! That is the record of an early steam automobile in Los Angeles, Calif., which still is able to bowl along the streets of that city at a good speed. The original owner of the machine is not known, although he is believed to have been the president of a western railway.

A quarter of a century ago, the machine represented the acme of the horseless carriage craft. Inlaid rosewood, trimmed with mahogany, decorates the interior and the seats are covered with the finest plush. The fixtures inside are silver plated. A speaking tube connects with the driver's seat and, for the convenience of passengers, a small writing desk can be unfolded from the wall. For lighting the car's path in 1903, both oil and carbide lamps were employed.

Despite the vehicle's age, its owner claims it will still be running when many cars of today are on the junk pile.

Steam auto of 1903, still running, has silver plated fixtures, plush seats, and interior trim of rosewood and mahogany.

Builds Sailing Yacht of Turkey Bones

A THANKSGIVING turkey furnished the keel for an unusual model yacht built by Harry Bock, a workshop enthusiast of Manchester Center, Vt. Upon the polished breast bone, the deck and masts were fastened. Smaller bones from the breast were used as spars to tauten the rigging of the miniature sails.

With ballast added, the unique toy vessel is said to be able to sail across a pond as successfully as any conventional model yacht. Its main interest, however, is as a curiosity and an unusual product of the workshop.

With its keel of a turkey's breast bone, this unique model yacht sails like a full-sized craft.

These "Cukes" Cannot Fail

A NEW hybrid variety of cucumber whose flowers do not have to be pollinated was described recently by Prof. Richard Wellington and Leslie K. Hawthorn, of the New York State Agricultural Experiment Station. The certainty of a crop is assured by this new species, they declared.

Plans to Use Tung Nuts for Making Paint Oil

OIL from Chinese tung nuts, which long has been used in paints and varnishes, will be produced on a large scale by T. Morris Carnegie, nephew of the late Andrew Carnegie, famous steel maker and philanthropist, if experiments being carried out on his estate near Fernandina, Fla., prove successful.

Mr. Carnegie estimates that mature tung trees will produce from 400 to 1,800 pounds of vegetable oil to the acre, quantities which, he believes, would make the production of his nut oil commercially profitable, just as oils from olives, peanuts, cottonseed, and other plants of the vegetable kingdom are now sold in large quantities.

Tung trees are already producing large quantities of nuts on the Carnegie estate. In China, these are crushed to make oil for paints and varnishes. In the East Indies an allied tree of the Chinese tung yields a wood oil known as gurjun balsam. Both these products, though little known in this country, have been in general use in the Orient for many years.

T. Morris Carnegie (at left) inspects oily nuts from Chinese tung trees on his Florida estate.

Can You Give a Name to Ultra-Violet Ray?

SCIENCE needs another word to designate what we now call ultra-violet light. "Ultra-violet" simply means "beyond the violet" band of the solar spectrum, which indicates that the rays are invisible and so are not light at all in the ordinary sense of the word.

Anyway, the discovery that these ultra-violet rays are necessary to life and are responsible for the vitamins in our food is being put to a thousand practical uses. An English farmer, V. M. Weall, of Surrey, experimented with pigs, exposing the porkers daily to ultra-rays from a quartz lamp for lengthening periods for ten weeks. Twelve pigs were untreated, as controls.

When the little pigs went to market the ones which had received the ultra-ray treatment were so much fatter and better that they brought far higher prices than the others, enough to repay the cost of the treatment fourteen times over.

Sign of the Pawnbroker Urged as Air Marker

NEW shapes and colors of glass are being sought for airway markers. How to mark radio antenna poles is a particular problem. Lights at the top are likely to cause interference. Floodlights at the bottom do not reveal the tips with sufficient clearness.

One suggestion is to place the familiar pawnbroker's sign of three balls at the top and illuminate it with a spotlight placed below.

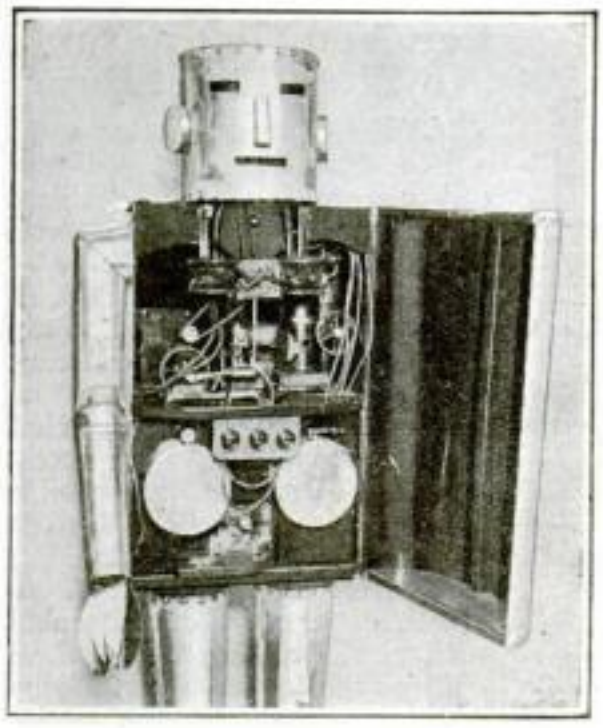
Electrified Water Keeps Fish Out of Ditches

AMAZING screens formed by streaming particles of electrified water are being used in the Northwest to keep young trout and salmon out of irrigation ditches. When schools of these fish stray into the ditches, loss results to the fishing industry, so experts of the Federal Bureau of Fisheries have been investigating to find the best method of turning them back at the mouth of a ditch.

They discovered that fish are sensitive to electric shocks and dread to pass through electrified water. So "electrical screens" were suggested and tried, using several schemes to electrify the water.

The same idea was adopted by the engineer of a power company on the Pacific Coast to keep fish out of the turbine wheels of a hydroelectric plant. On wooden frames over the water he suspended two rows of parallel electrodes which set up an electric field reaching to the bottom of the stream. The strength of the field tapered off in direct proportion to the distance up or down stream.

Thus each fish approaching the turbine wheels entered the electrified area and received a shock. If it did not turn back at the first shock, but swam nearer, the severity of the shocks increased rapidly as it approached the whirling wheels.



Boys Build "Human Engine" in Study of Anatomy

USING two furnaces for the stomach, twin bellows for the lungs, a little pumping engine for the heart, and other mechanical devices for various organs of the body, British schoolboys, studying anatomy, constructed a mechanical man to illustrate the functions of these organs by machinery. Their "human engine" simplifies the processes of the human body by giving a working demonstration of each organ.

When the furnaces generate steam, the pumping engine drives up and down the pistons which operate the bellows of the lungs. Then the mechanical man wheezes and throbs as though panting. A head, arms, and legs are fitted to the case inclosing the mechanical organs to add realism.

Nitrates from Africa

NITRATES essential in producing explosives in war time and valuable as a fertilizer in peace have been discovered in Southwest Africa, it is reported. Practically the whole supply in the past has come from the famous nitrate mines of Chile, in South America. The African product is said to be superior to the Chilean deposits.

Graf Zeppelin to Explore Arctic Near Alaska

IN APRIL, 1930, the great German dirigible *Graf Zeppelin* will point its nose toward the Arctic, according to Dr. Fridtjof Nansen, famous Scandinavian explorer, who will command the expedition. The airship will be used by the Aero-Arctic Society in exploring unmapped territory northeast of Alaska.

Dirigibles now occupy an increasingly prominent place in aeronautical news. Construction is under way at Akron, Ohio, of the plant that is to build the Navy's two 6,000,000-cubic-foot dirigibles. It will include one of the world's largest hangars—a building a quarter of a mile long.

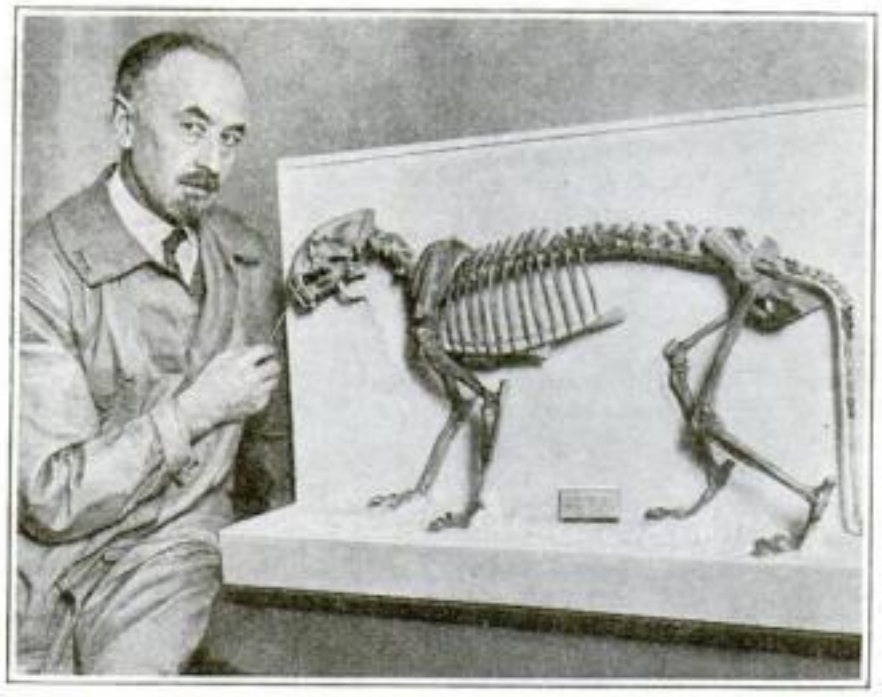
From France comes word that the Federation Aeronautique Internationale, the world-governing body of aviation, has recognized as official the *Graf Zeppelin's* eastward distance record. The entry:

"Class B (Dirigibles): distance (Germany), Dr. Eckener, with the dirigible *Z-L. 127, 'Graf Zeppelin'*; motors Maybach 450–550 HP, from Lakehurst, U. S. A., to Friedrichshafen, Germany, October 29–30–31, Nov. 1, 1928, 6,384.5 kilometers." This is equivalent to 3,967 miles. The last previous record in this class was set by two Italians who made a 503-mile dirigible flight in 1913.

First American Cat Had Teeth Like Daggers

ALL modern cats, from tabbies to Angoras, are believed by Paul C. Miller, associate curator of paleontology at the University of Chicago, to have descended from a prehistoric feline whose bones he found recently in Nebraska.

For thirteen summers he searched for the big cat of antiquity he believed had roamed over the western plains 10,000,000 years ago. His search ended in the basin of Hat Creek, Sioux County, where he discovered an almost perfect skeleton of the extinct animal. Measuring nearly four feet in length, it possessed powerful dagger-sized teeth to tear its prey.



Paul C. Miller, of the University of Chicago, with the skeleton of prehistoric cat, found in Nebraska, for which he searched 13 years.

Three Chemicals of Life Flow in Our Blood

THE three chemicals which play leading rôles in keeping us alive, blood specialists have decided, are hemoglobin, chlorophyll, and a phosphorus compound, still virtually unknown. This trio gives the blood stream its power. Hemoglobin, the red blood chemical, supplies iron to the vital current. Green chlorophyll, which tints plants, absorbs excess carbon dioxide gas from the air. The mysterious phosphorus compound forms the central nuclei of living cells.

It has been suggested that this phosphorus chemical is the one with which all animal life seems to have begun.

Hoard in England Adds to Bronze Age Mystery

THE so-called Bronze Age is generally believed to have been the stage in human culture intermediate between the Stone and Iron Ages, and to have lasted approximately from 2,000 B.C. until 1,800 B.C. Many archeologists of note, however, doubt that there ever was a distinctive bronze era, but contend that the three ages more or less overlapped, basing this belief on the fact that bronze implements have been found in ancient burial places side by side with iron and, sometimes, even stone ones.

Fresh impetus was injected into this question when workmen, digging for flint with which to build a road in the hills of Surrey, England, came upon an unusually complete and well-preserved collection of bronze tools and weapons. Many of the fine pieces were sent to a museum, where experts voiced the theory that the find was the buried hoard of an ancient caster who had placed his stock-in-trade in the ground for safe-keeping and then, evidently overtaken by some tragedy, had been unable to dig it up again.

Python Takes Whole Deer at One Gulp

A WHOLE deer disappeared down the throat of a huge python in the Malay States recently, according to the report of hunters who watched the record-breaking meal and then killed the serpent as it lay in a sluggish state while digesting the animal. Before this report was made public, goats were believed to be the largest animals which pythons could swallow.

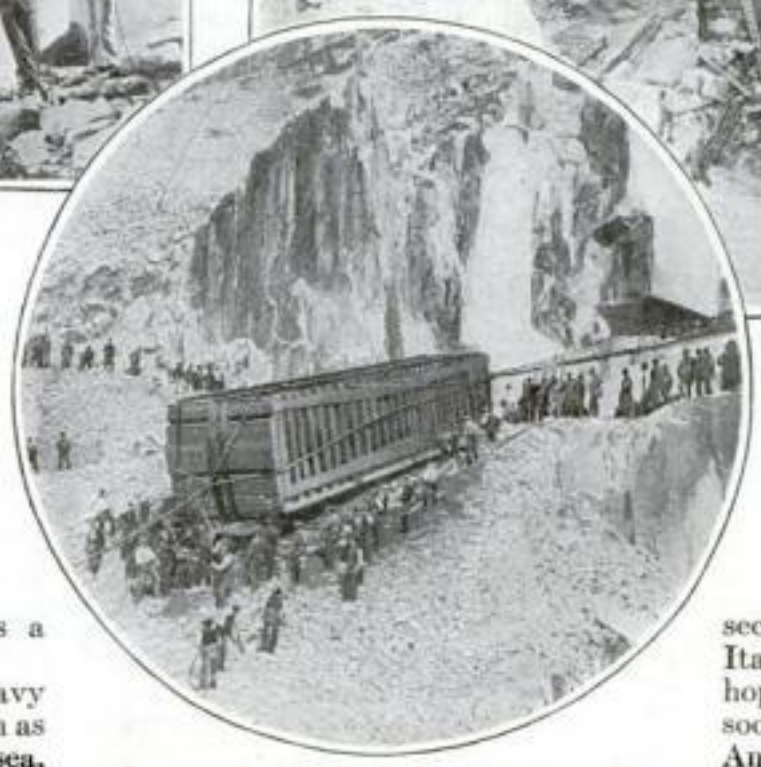
These huge snakes, able to crawl, climb, and swim with equal facility, weigh hundreds of pounds and often attain a length of thirty feet, causing them to be greatly feared throughout the tropical parts of Africa, Asia, and Australia which they inhabit.

After a victim has been killed by squeezing it to death, the serpent crushes the bones and mangles the body into the shape of a sausage so that it can be swallowed whole. Another peculiarity of the pythons is the manner in which the female hatches her eggs. Depositing as many as a hundred in a heap, she curls around them and remains in the same position without food during the period of incubation, which often lasts two months. It is thought this is not to keep the eggs warm, but to protect them from harm.

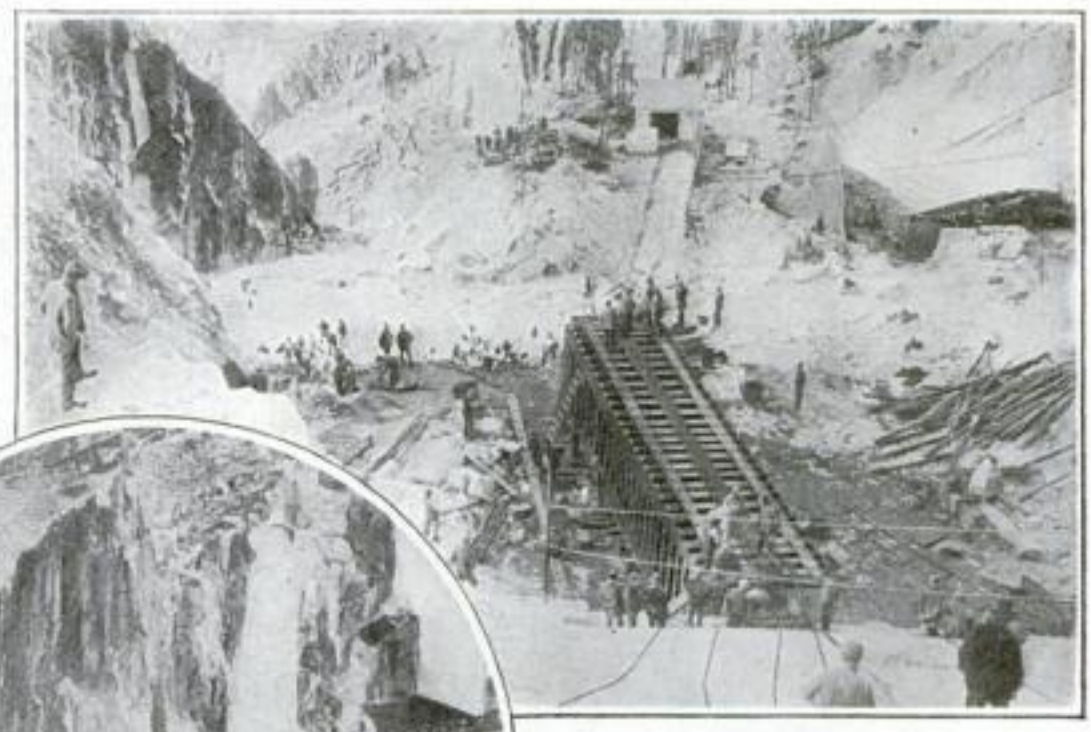
The python just after it had made a record by swallowing a deer. These snakes, often thirty feet long, weigh hundreds of pounds.

Five Years' Work to Quarry One Block of Marble

Comparison with the men in the photo shows the tremendous bulk of the marble monolith.



Stout steel cables slowly lowering the marble block along a specially constructed roadway.



Incased in heavy wooden jacket, the gigantic shaft is prepared for trip to Rome.

THREE thousand feet above the sea in the Italian Alps, workmen in the famous Carrara quarries drilled and cut for five years to carve from a mountain what is believed to be the world's largest monolith of marble. This white stone block, nearly ten feet square and sixty feet long, has been presented to Mussolini for erection as a monument in Rome.

The problem of transporting the heavy monolith—weighing 250 tons, as much as a powerful freight engine—to the sea, where it was loaded on a ship for Rome, was solved in a peculiar way. Those in charge, instead of consulting engineers, searched into history. A similar monolith of stone was known to have been brought to Italy from Egypt in the days of the old Romans. By scanning ancient records the method that had been used then was discovered and it was applied in lowering the Carrara block.

The shaft was incased in a fifty-ton covering of wood to protect it on the journey. In fastening and bolting in place the several layers of boards and timbers that clothed the monolith more than 10,000 nails and bolts were used.

Special steel cables of 160 strands each, made in Vienna, Austria, encircled the case and increased its strength. Cables of the same material also were used to steady the block. They were played out a little at a time as it slid down to the shore along a special roadway which, it is said, required more than a year to construct. With the web of taut steel cables steadying it, and guided by an army of laborers, the monolith descended by easy stages to the waiting vessel.

Gas Blows Up Mile of London Streets

A MILE of London streets exploded recently. With a series of roars like four huge bombs being set off, one after the other, an underground gas main burst in the west central section of the British capital.

The rushing clouds of inflammable gas ignited and, in an instant, tongues of vivid flame were shooting sixty feet into the air—higher than some near-by buildings. For whole blocks the pavement seethed with billows of fire.

Quick work by London "Bobbies" saved the day. An emergency call sent in cut off the gas supply before the fire had caused disastrous destruction.

Sixty-foot flames shooting five stories high when gas from a broken main explodes along a mile of London's streets.

Old Letter May Tell Secret of "Strad"

IF A yellow sheet of crumbly paper found recently in the secret drawer of an old desk at Bergano, Italy, turns out to be what musicians hope it is, every aspiring young violinist soon will play upon a coveted "Strad." An antiquarian, examining the piece of furniture, accidentally came upon a letter written by Antonio Stradivari, the master violin maker of Cremona, to a priest, setting forth in detail the methods of wood-treating and varnishing he used more than 200 years ago in the production of his matchless instruments.

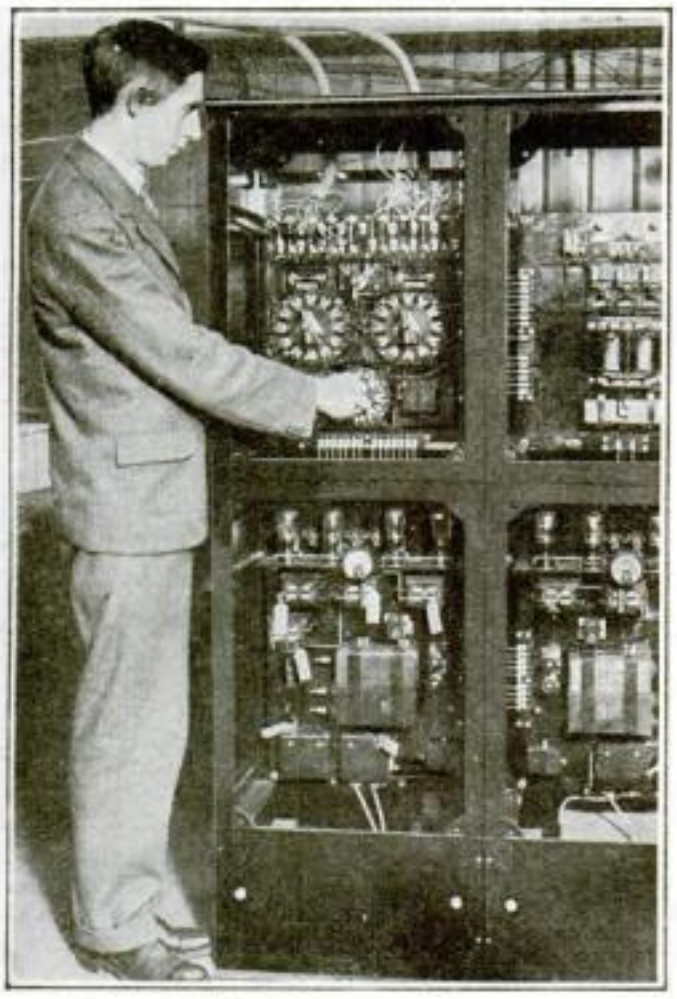
These secrets were supposed to have died with Stradivari and authentic violins signed by him, possessing unrivaled beauty of tone, are extremely valuable and eagerly sought for as a result.

At first, it is reported, it was the finder's plan to sell the letter to a violin maker in Milan, but when this was discovered by the authorities they prevented him from carrying it out. At present, the manuscript is in the hands of the Italian government.

Would Banish Cupid for Rule of Eugenics

TO LEAVE all matters concerning future generations to Nature is an error, in the belief of Ralph E. Danforth, of Chesterfield, Mass., an authority on eugenics, who holds the aim of eugenics is to improve the human race and make its individuals worthy of being loved.

"Increasingly more intelligence is required in our choice of lovers. The use of at least the same amount of intelligence and forethought in courting as in the less important branches of activity, such as dressing and eating, is demanded by common sense and by love alike," Danforth recently declared.



Electric "Bos'n" Shouts Orders on Warship

WITH ninety "tongues" singing out orders at the same time, an "electric boatswain's mate," recently installed on large British warships, spreads the command over all parts of a vessel within a few seconds.

Directions for the crew are spoken into a microphone and transmitted through the ninety loudspeakers placed at different positions on the ship. A single movement is all that is necessary to put the complicated mechanism in operation.

When the door of the case containing the microphone is opened, preparatory to giving an order, that action automatically sets the system in operation and the words spoken are shouted out of the loudspeakers within five seconds.

Quake Takes a Short Cut Through Earth's Center

TRAVELING from the Malay Peninsula to Massachusetts, vibrations of a recent earthquake passed through the center of the globe, according to seismographic records at Harvard University. Verification of the phenomenon comes from similar records at Georgetown University, Washington, D. C.

Had the vibrations followed their usual course and circled the globe at its surface, explained L. D. Leet, chief observer at Harvard, they would have been weak when they reached Cambridge. Because the vibrations registered on the American instruments with great intensity, it is concluded they must have passed through the center of the earth.

Angel Fish Bring Deadly Bacillus to Aquarium

A STRANGE marine bacillus which causes blindness and death to fish recently killed more than 400 specimens at the Aquarium, in New York City, before the epidemic could be stamped out. Angel fish from Key West waters are believed to have brought the death-dealing malady with them.

The only tropical denizens known to be immune to the disease are sharks, morays, skates, and eels. Other fish from semitropical waters first became blind and then died within five or six days after being infected.

The disease was checked by pumping out 100,000 gallons of water used in the Aquarium's tanks and replacing it with water from New York Bay.

Sound Films to "Talk" in Testing Studio

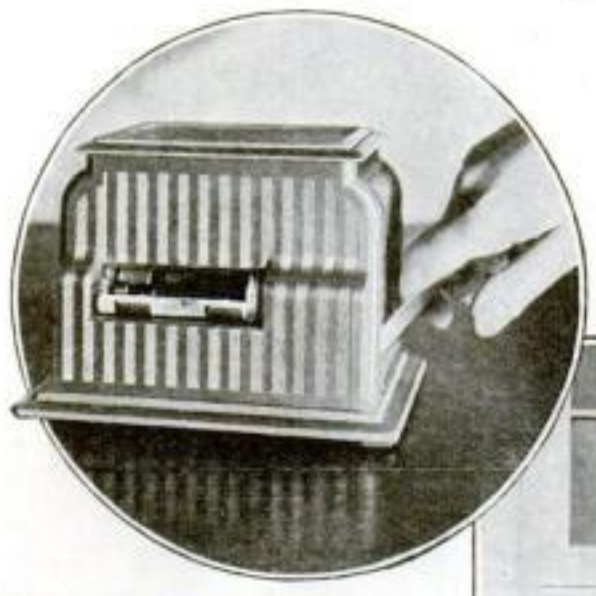
A THREE-STORY laboratory, to be devoted wholly to the study of problems in connection with talking movies, is being constructed by the Bell Telephone Laboratories in New York City. Facilities for the complete production of sound films for experimental purposes will form part of the equipment.

The top floor of the building will be occupied by a large studio where the programs will be heard under acoustic conditions similar to those of a theater. A plant of the latest design for handling and developing talking films will be on the ground floor. The films and recordings produced in the laboratory will not be used commercially, it is explained, but will be set aside for experiments leading to the expected improvement of sound film production.

Ready-Lighted Cigarettes Pop from This Holder

PRESS down the lever of a new cigarette box and out comes a cigarette already lighted! The movement of the lever releases a single cigarette, allowing it to drop upon holders, and at the same time ignites a lighter, similar in action to an ordinary pocket lighter.

When the cigarette is removed, it is ready to smoke. Releasing the lever automatically extinguishes the lighter. The novel humidor has a capacity of forty to fifty cigarettes.



Ready for smoking, a lighted cigarette pops out when you press lever of this automatic humidor.

How Much Do You Know About Physics?

HERE are ten questions selected from hundreds asked by our readers. See how many you can answer. Correct answers are on page 143.

1. What is the difference between chemistry and physics?
2. What is a vacuum?
3. How does a thermometer tell temperature?
4. What is the difference between a steam engine and a gasoline engine?
5. What is the difference between a wave in water and a sound wave in the air?
6. If water won't run uphill, why does a siphon work?
7. Is there any transparent metal?
8. What becomes of the power used to drive an automobile when you take a ride and return to the starting point?
9. How does light register a picture on a photographic plate?
10. What is "cold light?"

Deliveries Locked Up by Kitchen-Wall Receiver

TO SAVE steps and protect packages left when no one is home are the purposes of a device designed to be installed in the kitchen wall. It is a compartment with two doors, one outside the house, the other within the kitchen.

When groceries, bottles of milk, or parcels are deposited in the receiver, closing of the outside door locks it automatically, the maker explains, thus protecting the articles from theft. When the inner door is opened, the catch on the outer door is released, thereby unlocking it for further deliveries.

The size of the receiver is sufficient, if installed in a frame house with a six-inch wall, to accommodate six quarts of milk or articles occupying a similar space.

Your daily milk supply is protected from theft when automatically locked in this parcel receiver in the kitchen wall.

Know Your Car

THE function of a car's cooling system is the transfer of excess motor heat to air flowing through the radiator. Assuming that the cooling system keeps the motor at proper running temperature in the hottest weather, it is neither necessary nor desirable to put anything in the radiator except pure water. This does not apply, of course, to antifreeze liquids, to prevent the water from freezing in cold weather.

If, after several years of use, you find your motor has a tendency to heat, it is because the cooling system is clogged with rust flakes from the iron cylinder jackets, or perhaps from water deposits. The only way to restore the radiator's efficiency is to flush it thoroughly with a strong solution of boiling hot lye. This treatment should not be necessary until your car is at least two or three years old and then only when the water is particularly hard.

Devises Weights to Stop Trains from Crashing

SOMETHING new in the way of safety appliances to reduce railway accidents has been devised by G. S. Oliver, an Englishman, in the form of a mechanical device to prevent train collisions at crossings.

Using two toy engines on tracks that crossed, Oliver recently demonstrated his theory that levers attached to heavy rolling weights placed at intervals along the rails would stop locomotives from colliding.

When two trains approach a crossing at the same time, the inventor says, the weighted levers catch projections on the rear of the locomotives and slow them down, preventing them from crashing at the intersection. To lessen the strain of a sudden stop, Oliver explains, the weights roll back sufficiently to bring the trains gradually to a halt.

G. S. Oliver shows how his weighted levers operate to slow down toy engines in peril of crashing at rail crossing.

Finds Germs Existed Before Dinosaurs

GERMS have outlived the dinosaurs. While the huge monsters of the past have vanished from the animal world, microscopic bacteria have continued to live with but slight changes for millions of years, Prof. T. Brailsford Robertson, of the Wistar Institute, Philadelphia, recently reported.

A study of bacteria discovered in the soil of Australia showed that they resembled the bacteria found in soils in other parts of the world. Because of the striking difference between the larger animals of Australia and those on other continents, naturalists believe that Australia has been separated from other land masses for millions of years, so that the life there has had an independent evolution.

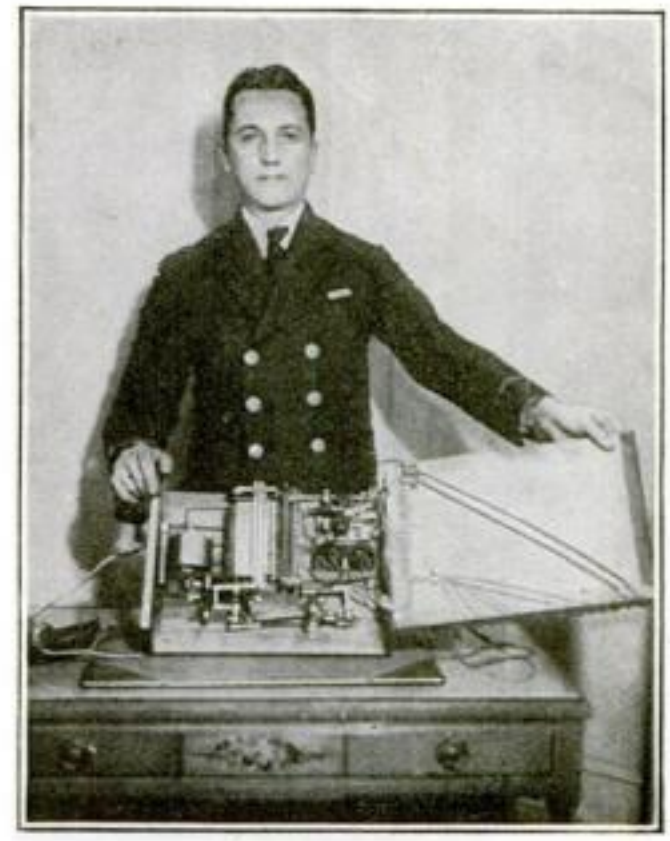
The fact that the germs in the soil have not become different from those on other continents leads Professor Robertson to the conclusion that they have remained the same during all that time and are the oldest things living on earth.

Lock-It-Open Latch Foils Winds and Robbers

TO PREVENT a window from rattling and to hold it securely so it cannot be raised further from the outside when opened a few inches for ventilation, an ingenious window lock has been invented by Joseph Neiser, of London, Ohio.

His latch consists of a right angle rod which fastens into a slot in the side of the upper sash. The lower end of the rod is threaded and carries two lock nuts which can be screwed tight around a projection on a standard fastened to the top of the lower sash. When the window is to be locked open three inches at bottom or top, the nuts are screwed to the top of the rod and clamped about the standard projection while in that position. When the window is locked shut, the nuts are tightened near the lower end of the rod and the device is locked to the standard. According to the inventor the lock does not interfere with free working or cleaning of windows, as it can be lifted off.

Lock-it-open latch keeps window from rattling or being raised.



Automatic Device Sends Out S O S Calls

WITHOUT a knowledge of radio or code signal, anyone now can send out distress signals from a ship or airplane, it is announced. The signal gives the position of the craft and its call letters in the international radio code, all automatically. The automatic device was invented by Lieut. C. A. Perez, of the Cuban Signal Corps, and it recently was tested before U. S. Navy officials.

All that is necessary to operate the transmitting device, it is explained, is to plug in the correct latitude and longitude indications, then throw a switch. Complete, the instrument weighs only fifteen pounds and is about the size of a portable typewriter. Because of its compactness and light weight, the inventor expects it to be used widely in aircraft.

"Sneezing" Plants Spray Their Seeds into Air

SNEEZING plants that spray their seeds into the air with each "kachoo" are described by Herbert H. Whetzel, professor of plant pathology at Cornell University, Ithaca, N. Y.

They are various types of destructive fungi. Their cup-shaped seed holders are filled with tiny pods, each containing eight seeds. In each seed pod is a charge of starch which ferments and explodes, Professor Whetzel explains. This explosion blows the microscopic seeds an inch or more into the air. They float about, land on plants, and take root.

Professor Whetzel has obtained a photograph of a large number of pods exploding at once, with a cloud of the seeds swirling in the air above.

Wanted—Three-Eyed Fish!

ONE thing biologists want to see is a three-eyed fish. Dr. E. W. Gudger, of the American Museum of Natural History, New York City, has a photograph of a haddock with three eyes, but the original specimen never came under scientific observation. Anybody with a three-eyed fish should send it to the Museum, preserved in formaldehyde.

Getting the Best Tone from Dynamic Speakers

How to Build a Simple and Attractive Baffle Board That Will Give Natural Reproduction of Radio Voice and Music

By ALFRED P. LANE

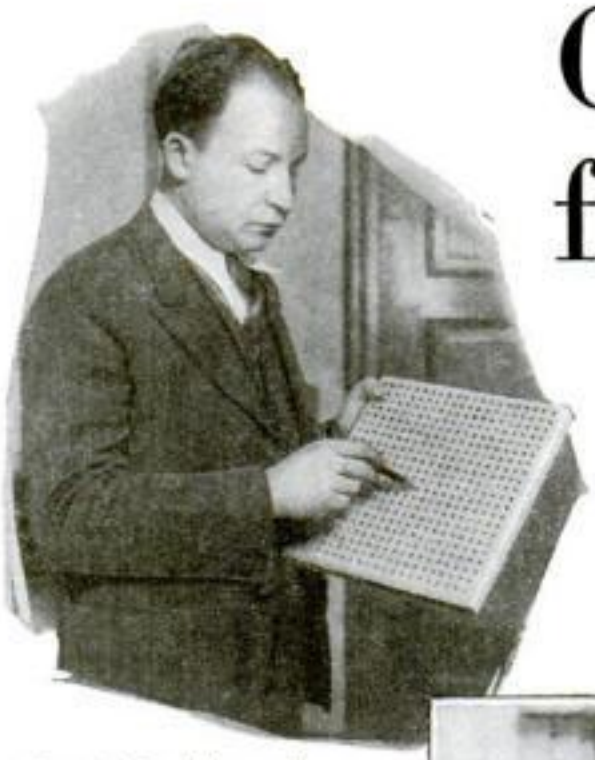


Fig. 1. Special acoustic material of cane fiber. Its surface is peppered with holes to increase absorption of sound.

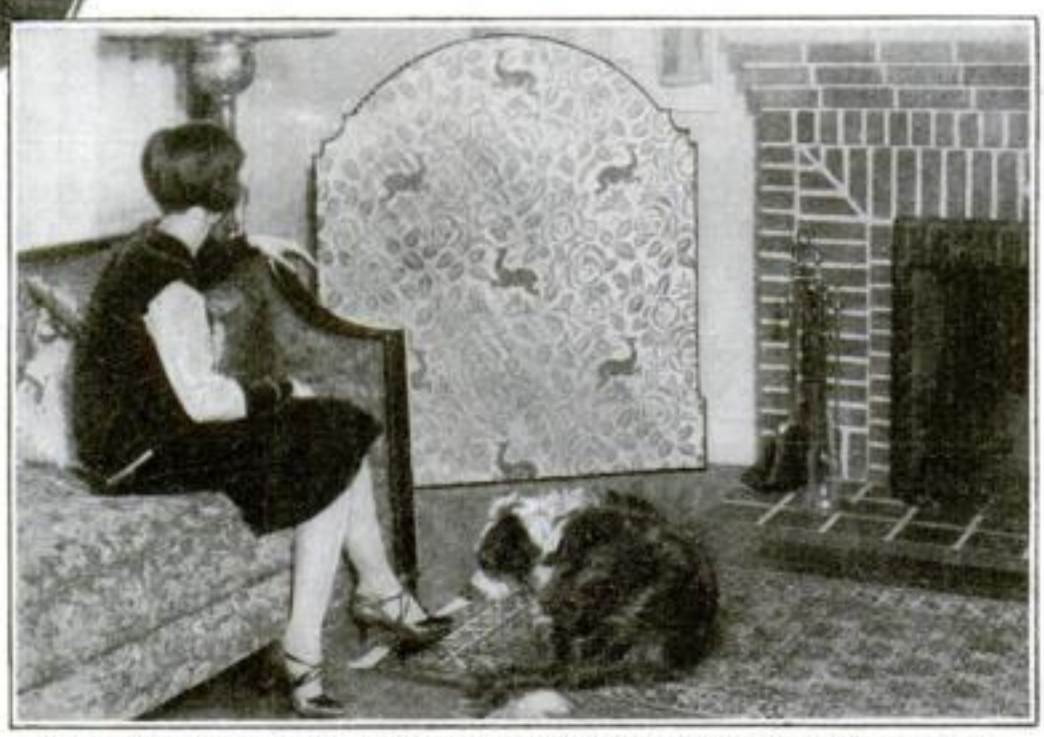


Fig. 2. How you can make an otherwise unsightly baffle board into an attractive screen for the living room. The shaped board is covered with light upholstery fabric.

"I'M GETTING plumb discouraged," complained a radio dealer to me the other day. "There's some funny angles to this radio business, and the question of tone quality sure heads the list."

"What's so funny about tone quality?" I asked him.

"Well," he explained, "it's like this. Most of the birds that drift in here to get radio receivers tell me how they have very sensitive ears and how they're chiefly interested in getting real true tone quality—and when I give it to them they don't recognize it!

"Here," he added, snapping a plug in a wall socket, "just listen to this and tell me what you think of it."

After the tubes heated, the strains of a jazz band issued from the loudspeaker. "That's not so bad," I observed.

"Now listen to this one," he growled, switching plugs, and in a few seconds the strains of the same jazz band came from another loudspeaker.

"That's much better," I exclaimed, for the second trial was clean-cut and brilliant. All the low tones were coming through and the higher frequencies as well. It was a close approach to true musical reproduction, and I told him so.

"Of course it is," he agreed, "but most people think that first set is better. 'Beautiful mellow tone' they call it. Mellow is right! Like a 'mellow' egg—soft and a bit ripe!"

That dealer, who is an exceptionally good musician, was merely exaggerating a novel state of affairs that exists today. Many people actually prefer their radio music distorted; which is rather strange, because only a short time ago everybody was striving for good tone quality and condemning distortion. The difference lies simply in the fact that whereas the distortion formerly was caused by lack of the low frequencies, the 'mellow' form of distortion that appeals to some people now is caused by leaving out or deliberately cutting off a large percentage of the higher frequencies.

True tone quality, which means simply accurate reproduction of the sounds produced in the broadcast studio, depends on many factors. As has been explained in previous articles in POPULAR SCIENCE MONTHLY, radio reception is like a chain that is only as good as its weakest link. The receiver must be capable of doing the job, the tubes must be in good condition, and the loudspeaker must be capable of converting the electrical impulses into sound impulses with the least possible distortion.

GRANTED you have a good receiver, the dynamic cone type loudspeaker is admittedly the most perfect form of loudspeaker, provided it is used under conditions that will permit it to do its best work. Unlike the ordinary magnetic cone, the dynamic cone speaker is only part of the complete loudspeaker equipment. The function of the vibrating cone of the dynamic speaker is to impart its vibrations to the air with which it is in contact. The function of the remaining part of the loudspeaker equipment is to see that these air vibrations are propagated into the air of the room without additions or subtractions.

Sounds, as you know, are waves in the air. The only difference between sound waves and the waves in water is that in the former, the particles of air move back and forth in the direction the wave is traveling instead of across the line of motion, as with water waves. A sound wave is simply a series of rapidly expanding rings about the source of the sound. Each ring is an area in which the air is compressed, and the space between the waves is an area in which the pressure is below normal.

The cone of the loudspeaker moves back and forth as a complete unit and therefore acts like a piston. While it is moving in one direction it is starting a band of compression on one side and an equivalent band of low pressure on the other side. Two sound waves are therefore produced at the same time, one from the front of the cone and the other from the back.

When these two waves meet at the edge of the cone, the high pressure area neutralizes the low pressure area from the other side, and the result is that no sound wave issues into the room. This effect naturally is much more pronounced on the long waves of the low tones than on the short waves of the high notes.

This means that when a dynamic loudspeaker unit is used alone you cannot hear the low notes because their energy is absorbed and canceled outright at the edge of the cone before it can be transmitted to the air of the room.

THE obvious remedy is to prevent the two air waves from killing each other by keeping them apart. And that is the function of the baffle board or cabinet which completes the loudspeaker equipment.

The dynamic speaker baffle board is in no sense a sounding board like that used in a piano to reinforce the vibrations of the strings. Theoretically the baffle board should be incapable of vibration. It is simply a partition to keep the front waves and back waves from

exterminating each other. An ideal baffle board would be one made of solid lead an inch or two thick. But such a baffle would weigh about a ton, and the expense would make it impractical.

The use of a baffle board is, of course, the simplest way for you to get good results out of a loudspeaker. However, other members of the family may throw up their hands in horror at the idea of putting a large and ugly board in the living room. Consequently, your problem is to overcome these objections while producing a dynamic speaker baffle board that will give the best tone quality.

FIGURES 2 and 3 show a satisfactory solution of the problem. The baffle board is made of two sheets of plywood with a layer of cane fiber board between. It forms an excellent soundproof partition. The cross bracing at the back, as shown in Fig. 3, gives rigidity and helps to prevent warping.

While the design of this particular baffle board is attractive, there is no magic in the shape. You can change the top and side outline to suit your own ideas or to harmonize with other furnishings in the room. It is not necessary to have an ugly, gaping hole showing in the center of the baffle board, where the dynamic cone is fitted. The hole is there, of course, but it is concealed by a light upholstery fabric which is stretched over the entire board. Any sort of fabric can be used. Cotton print is good and also cheap. It will be well to let the lady of the house pick out the material. The rim of the board is covered with upholstery edging and studded with brass-headed upholstery tacks. Here, too, your own ideas may be allowed full play.

The only important restriction in the design of the baffle board is a predetermined figure for the distance from the edge of the hole in the center to the nearest edge of the baffle. This distance governs the low note reproduction you will get. The rule is to make it not less than one eighth of the wave length of the lowest note you want to reproduce.

SOUND travels at 1,025 feet a second, and you can determine the length of a sound wave of any given frequency simply by dividing 1,025 by the tone frequency. A tone vibration of 100 would therefore be 10¼ feet long. Dividing again by 8 gives a trifle less than 15½ inches as the minimum distance from the edge of the baffle to the edge of the hole, if you want to reproduce tones down to one hundred a second. The smallest possible baffle board which would give you this frequency would therefore be a circle 39 inches in diameter, assuming that you have a nine-inch hole in the center in front of the dynamic cone. If you want to get down to 30 cycles, the baffle board would have to be nearly nine and one half feet in diameter.

It must be understood that the effect of the baffle is not as sharp and definite as these figures would indicate. The 39-inch baffle would give you some response at 30 cycles, and so on. For practical use it is not necessary to make the baffle any larger than the one shown in Fig. 2, which measures 54 inches from top to bottom and 45 inches across. The radius of the curved top was drawn from the center of the hole for the cone and is half the width of the baffle.

A screen baffle of this type, decorated to match the furnishings of the room, adds to the appearance of the room and is at the same time the simplest, cheapest, and least troublesome way of getting the best possible results out of any make of dynamic speaker unit.

Note that cheap lumber from old crates can be used for the back bracing, since the back of the baffle does not show when placed in position in any convenient corner of the room.

Many owners of dynamic cone speaker units have attempted to fit them into cabinets instead of using baffle boards. In most every case trouble is encountered with resonance effects caused by the air space confined in the cabinet. A most unpleasant and decidedly unnatural "barrel tone" is produced. The tones in musical selections that coincide with the resonance period of the confined air in the cabinet are overemphasized. The music sounds as if it were coming out of the bottom of a well and the announcer sounds as though he had a throat about a foot in diameter.

IT IS possible to eliminate this trouble by fitting the front of the cabinet with a thick baffle board made of a sound-absorbing cane fiber material, which is sold in large sheets. Then the entire inside surface of the cabinet must be lined with the same material or with thick layers of felt. A special cane fiber board that has remarkable sound absorbing qualities has been developed for such purposes, as well as for use in cutting out resonance in broadcasting studios. A standard size piece of this material is shown in Fig. 1. Note that its surface is peppered with holes. These extend about three quarters of the way through. The theory is that the holes greatly increase the surface and consequently the sound absorption. Laboratory tests in the Popular Science Institute of Standards show that the theory is well founded.

Fig. 3. Rear view of the board, with dynamic cone in place. Note cross bracing, which gives rigidity and helps prevent warping. It can be made of cheap lumber taken from old crates.

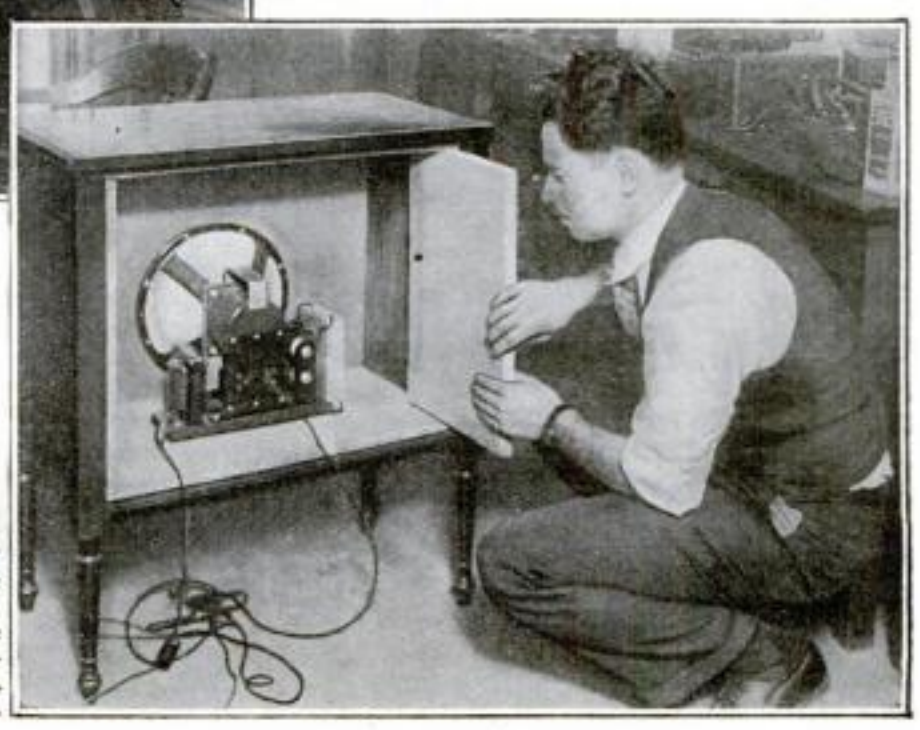


Fig. 4. To prevent unnatural "barrel tone" when the dynamic cone is placed in a cabinet, fit the front and line the interior with sound-absorbing material. Back should be open.

THE effect of a cabinet on the dynamic cone loudspeaker should be the same as that of a baffle board. It should keep the sound wave from the front of the cone from annihilating the wave from the back of the cone. Theoretically, it would be fine if you could entirely eliminate the wave from the back of the cone. At first glance it would seem that inclosing it in a cabinet with no opening except the hole in the front would accomplish just this result. Unfortunately, it does not work out that way. Inclosing the air back of the cone will make the air act as a damper and prevent the free motion of the cone, with disastrous effect on tone quality.

The back of the cabinet should be left entirely open, as shown in Fig. 4, to prevent this effect; or if the outfit must be placed where the back can be seen, then cover it with thin silk or cotton cloth of a color to match the cabinet.

The effect of lining the cabinet with sound-absorbing material is to absorb that portion of the sound wave that strikes it and thereby prevent it from being reflected back to cause resonance or "barrel tone" effects. Some readers may think that a baffle board applied to an ordinary magnetic cone speaker would result in an outfit just as good as that in Fig. 2. That is not so, because the ordinary magnetic cone is not capable of reproducing the low frequencies and because the magnetic cone has almost no piston action.

THE effectiveness of a cabinet as a dynamic cone baffle is determined in the same manner as is that of the plain baffle board. The measurement is made from the edge of the hole in front, around the corner to the opening in back.

If you are confronted with special problems in the construction of a baffle board, or in obtaining the proper materials for lining a cabinet, address your inquiries: Technical Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

How to Hook a Phonograph to Your Set

Useful Ideas for Radio Fans

Electrical Pick-up Simplified—The Secret of Good Tone Quality—Special Receivers for Special Needs

THE conventional method of hooking the electric phonograph pick-up to the radio receiver is to substitute a special plug for the tube in the detector socket. This method gives good results but is somewhat inconvenient because of the necessity of removing the tube each time you wish to shift from radio reproduction to phonograph record reproduction.

The novel device pictured on this page gets around this difficulty. The special plug is placed in the detector socket and the tube prongs are inserted in the holes in the adapter. Then the special switch is mounted at any convenient point on the panel of the receiver and the phonograph pick-up is connected to the wire ends shown at the lower right in the illustration. The switch plate is marked "RADIO" and "PHONO," and throwing the switch instantly changes from one to the other kind of reproduction.

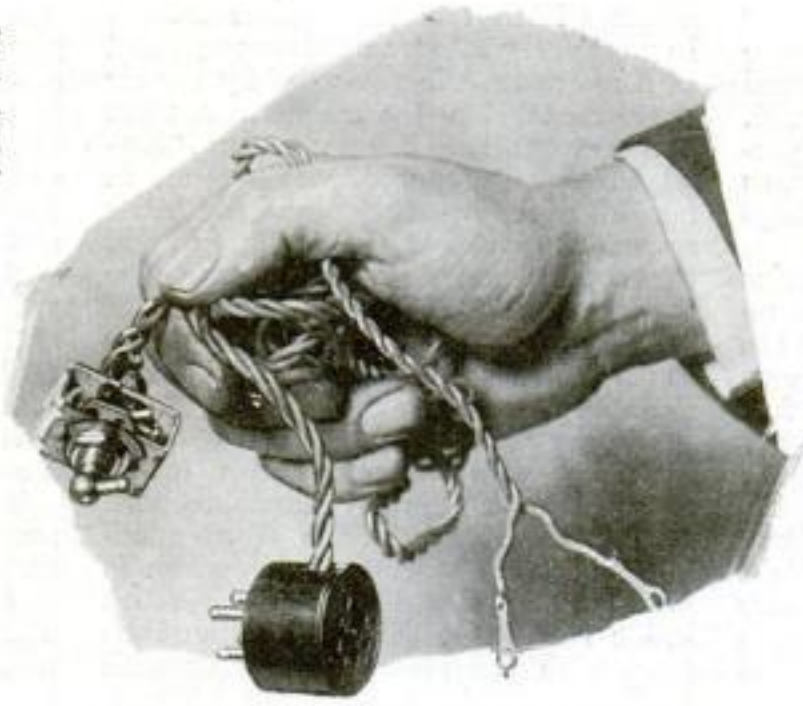
What this special switch or the ordinary plug attachments accomplish is, of course, to connect the electric pick-up to the input terminals of the first stage audio transformer.

In sets where a jack is provided on the panel, into which the cord from the phonograph pick-up may be plugged, the same end is attained. To fit such a jack to your set, use a double-circuit jack (four-prong) and connect the P and B terminals of the first-stage audio transformer to the upper and lower lugs on the jack. Then connect the wires that were connected to these transformer terminals to the remaining lugs on the jack. Make sure that when there is no plug in the jack the circuit will be restored by the contact springs, just as it was before you installed the jack. In other words, the P terminal of the transformer must be connected to the wire from the P terminal of the detector tube socket.

Tone Quality from Records

MODERN methods of electrical recording give us phonograph records that contain in the wavy grooves a remarkably true record of the actual music or speech. However, the electrical pick-up is no miracle worker. All it can do is to convert the mechanical motion of the needle into equivalent electrical impulses, and the tone quality of the music issuing from your loudspeaker will depend on how accurately you amplify these impulses to loudspeaker volume. If you have an old-style receiver fitted with poor audio transformers and your loudspeaker is of an obsolete type, the modern record will sound no better than if played on an old-style, tin-horn phonograph.

In any case, the phonograph record will sound no better than the radio reproduction from the same receiver. High quality reproduction is the same problem whether the original sound impulses come from the detector tube of the receiver or from the phonograph record by way of an electric pick-up. This means that any radio receiver capable of giving good tone quality on broadcast music will do equally well operating from an electrical pick-up. The possible volume without distortion, either on broadcasting or from phonograph records, is limited by the type of power tube that is used in the last audio stage of the radio receiving apparatus.



This special plug and switch makes it possible to change instantly from radio to phonograph reproduction.

A B C's of Radio

THE component parts of a receiving set are made of materials chosen because of their ability to carry electric current or to resist its flow. Thus connecting wires are of copper, and condenser plates of brass or aluminum, because these have little resistance to the flow of current, whereas bakelite, hard rubber, fiber board, wood, and glass are used to stop current flow.

However, no metal is a perfect conductor of electricity, and the insulators mentioned are far from being absolute nonconductors.

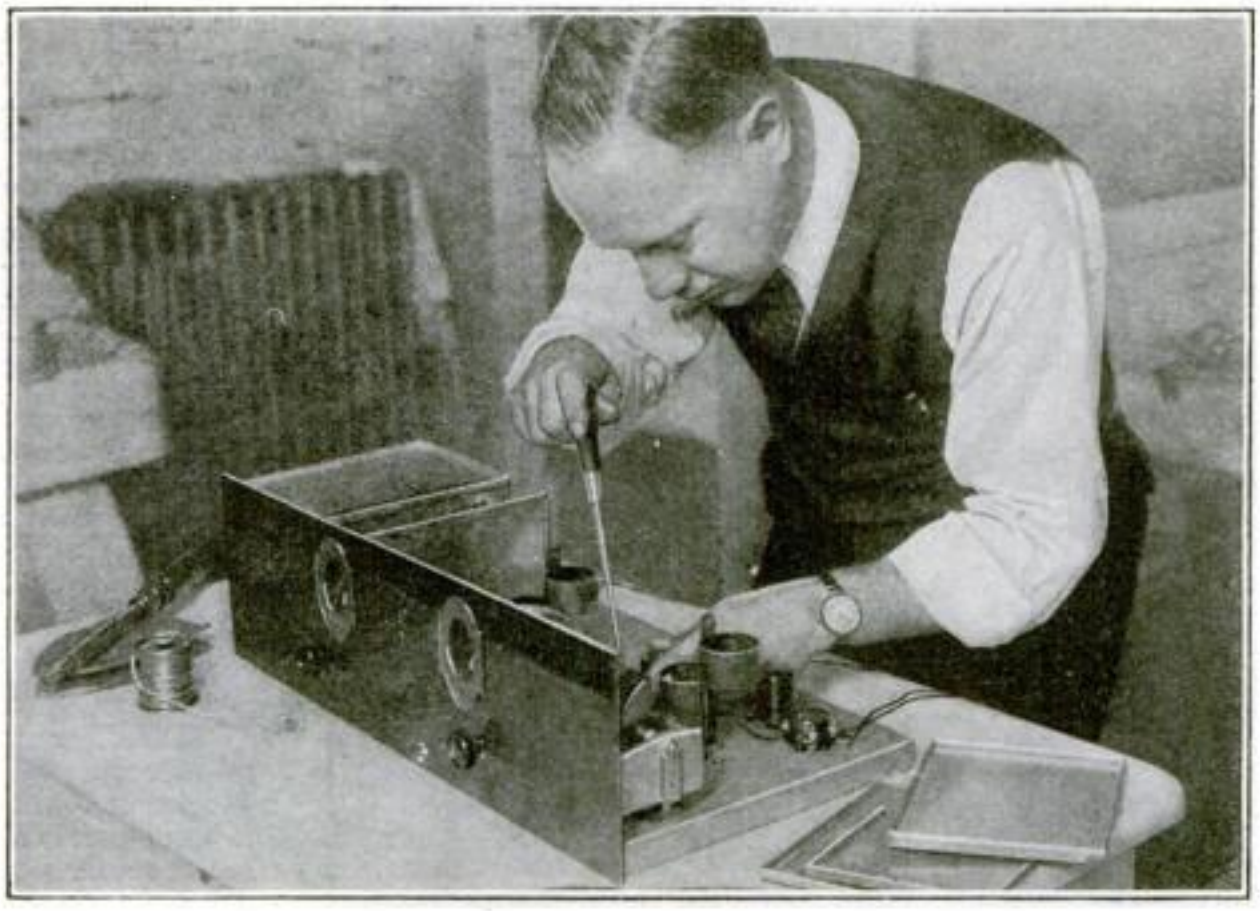
Electrically, therefore, the only difference between conductors and insulators is that the former have low resistance; the latter high resistance. And the resistance of any insulator depends largely on how much moisture it absorbs in a damp place. Glass absorbs almost none, while untreated wood, highly resistant when dry, becomes a relatively poor insulator when damp.

Special Receivers

WHILE the radio demands of most people are supplied by the conventional radio receiver, there are many cases where a special receiver can be designed that will give more satisfactory results. For example, take the case of a partly deaf person located reasonably near a number of broadcasting stations. To obtain sufficient volume from a loudspeaker to afford good hearing for such a person would mean the use of a set capable of tremendous volume on the loudspeaker. The volume would, in fact, have to be maintained at a level objectionable to anyone with normal hearing. You couldn't operate such an outfit in an apartment house without getting in wrong with neighbors above and below.

A simple solution is the construction of a plain three or four tube set consisting of a stage of radio-frequency amplification to provide selectivity, a detector, and one or two stages of audio amplification. Build it for storage battery or dry cell tubes, as desired, but do not bother with a power tube in the last stage and keep the plate voltage down to forty-five volts. That voltage on a plain tube will handle all the volume a pair of headphones will stand—plenty to afford good hearing to anyone not stone deaf. Eliminating the power tube, the high B-voltage, and the need for C-batteries will result in an inexpensive and easy-to-build outfit.

Three Ways to Build a Radio



If you have no home workshop, you can easily build a kit set on the kitchen table. All the tools you need are a long screw driver, wire-cutting pliers, soldering iron, and rosin-core solder.

You Can Be Your Own Designer, Follow a Blueprint, or Assemble a Kit Set—Which? Here Is the Answer

By JOHN CARR

YOU can tackle the problem of building yourself a radio receiver in any one of three different ways.

If you understand what each component in the radio circuit actually accomplishes, you can design your own receiver. This means working out a circuit that will meet your particular requirement, choosing apparatus based on the electrical characteristics of the parts available, and then proceeding with the construction and wiring of the receiver according to your own ideas.

You can learn a lot about radio by following this method, but if you are a beginner, it is likely that the experience will prove costly and the results won't amount to much.

The second way is to obtain a blueprint showing you how to build and wire the receiver and what parts to use. By using a POPULAR SCIENCE MONTHLY radio blueprint you will be following this method. Such a blueprint does not save you any of the actual labor of building the receiver, but it does save you the trouble of figuring out a circuit and choosing parts for it. In other words, the designing is all done for you. If you accurately follow the blueprint and instructions, you can be sure the finished receiver will give good results, because you will be duplicating the model receiver from which the blueprint was made.

The third and easiest method is to purchase a complete kit of parts. This way is easiest because you don't have to drill, saw, or file anything. All the parts are supplied down to the last screw and nut so that, in effect, you purchase a complete receiver in knock-down form. The front panel and the metal base both come drilled for the parts to be fitted to them. A package accompanying the kit contains all the various screws, nuts, and such small hardware, as well as special parts needed in assembling the outfit. An instruction booklet shows just how to proceed with the assembly and wiring.

Assuming that you want to build a receiver, which method should you adopt? The first we can disregard, because if you are expert enough to follow it, you won't need advice. That leaves a choice between the second and third methods, and deciding between them depends on a number of factors.

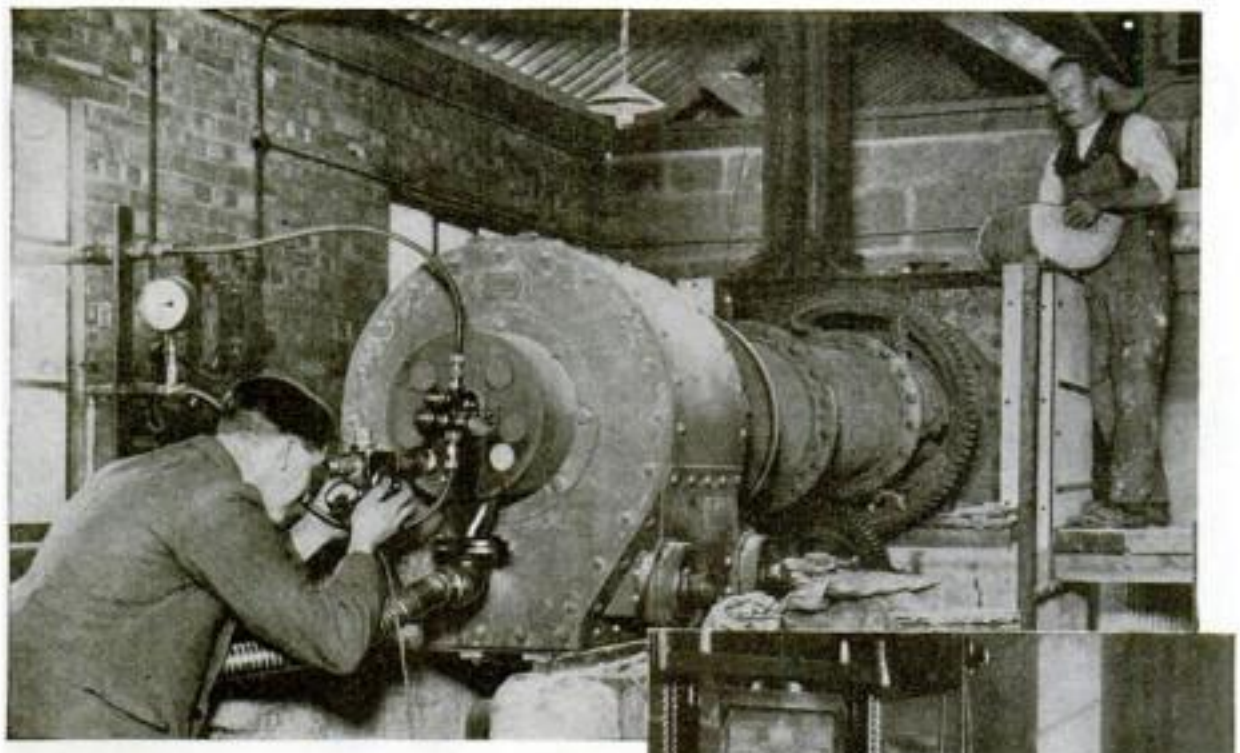
ESSENTIALLY it hinges on whether you like to do simple, home workshop jobs, such as drilling holes and using such tools as a hack saw or file in the operations needed to fit the dials to the panel, the panel to the baseboard and, of course, the construction of the baseboard itself. If you already have a home workshop where you make things, the mechanical work of building a receiver according to a POPULAR SCIENCE MONTHLY blueprint will seem extremely simple.

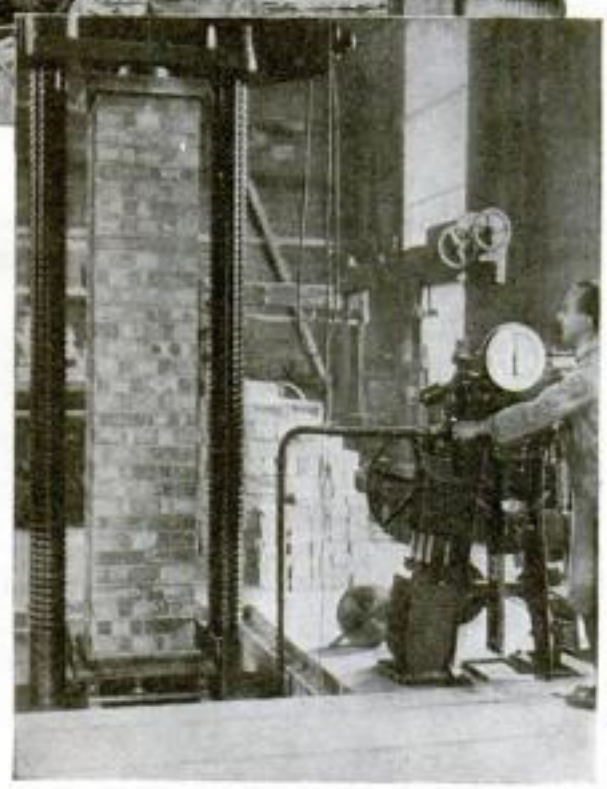
On the other hand, you may have no workbench and none of the necessary tools. In that case, to build a receiver requiring mechanical operations, you will have to purchase tools and find a place to do the work.

Here is where the complete kit fits in. All the assembling can be done on the kitchen table as shown in the illustration. Since all mechanical operations have been performed for you in advance, it becomes merely an assembly and wiring job, and the tools you need for this work are few. Of course you want a screw driver, preferably one with a long, thin blade. It will get down between other parts to tighten a screw where a short screw driver cannot be used. Then you will need a pair of wire-cutting pliers, both to cut the wire to the proper lengths and to hold the nuts while you tighten the screws with the screw driver.

The only other equipment you need is a soldering iron and a supply of rosin-core solder. An electric soldering iron will be found very convenient and will save much time, but equally good work can be done with an ordinary soldering copper heated to the proper temperature on the kitchen stove.

THERE are, of course, inferior radio kit sets on the market, just as there are inferior complete radio receivers. Before you buy, therefore, it will be well to write to the Popular Science Institute of Standards for information as to which radio kits have been tested and approved. You naturally want to know that the circuit of the kit set is good, that the parts are electrically and mechanically suited for use in the circuit, and that the parts are accurately made so that they will go together without trouble.





Testing the strength of a brick column under tremendous pressure in the laboratory. Top photo: An expert observes the effect of heat on samples of cement in a rotary kiln

England Seeks Fog-Proof Building Materials

A BATTLE against the atmosphere is being carried on by Great Britain through its Department of Scientific and Industrial Research. At Watford, north of London, experts in the Building Research laboratories of the government are seeking better building materials to fight the crumbling effect of England's foggy weather.

Some gases of the air, notably carbon dioxide, combine with building materials to form acids destructive to stone and mortar. The damp climate of the British Isles is said to hasten such action. Recently it was revealed that Westminster Abbey, the Houses of Parliament, and other structures have been weakened by such atmospheric action.

Since nothing can be done about the climate, scientists are seeking new construction materials less easily affected. One of the first steps was to test the limes and cements on the market. Samples of each were burned in a rotary kiln while one of the experimenters watched the dazzling mass of flames, and a pyrometer recorded the temperature at which the material was consumed. The lime and cement which burned and crumbled most slowly was considered the best to withstand the action of the atmosphere.

Another experiment determined the resistance of piers, columns, and walls made of brick. A compression-testing machine, electrically operated, exerted a pressure almost equal to the weight of the world's largest locomotive upon them to find the strongest mortars and bricks.

Discovers Vast Plateau on Brazilian Border

A FERTILE plateau, larger than the state of Maryland, was discovered recently on the border between Brazil and Dutch Guiana by a Brazilian army officer, General Candido Rondon, while making a survey of that unexplored region.

After penetrating into the jungles north of the Amazon, he reports he emerged upon "a vast plain of rich pasturage." Its extent, he believes, is at least 15,000 square miles. General Rondon was one of the men who accompanied Theodore Roosevelt down the River of Doubt.

Physician Feeds Patient Through Pores in Skin

TURNING back time perhaps a billion years, when the earth's earliest inhabitants, the protozoa, or unicellular animals, absorbed food through their microscopic bodies, Dr. Karl Stejskal, a Viennese physician, recently demonstrated that the pores of the human skin will act as mouths, and that man may be fed through any part of his body.

Confronted with the case of a patient whose digestive organs were diseased to a point where starvation was almost inevitable, Dr. Stejskal conceived the idea of rubbing essential foodstuffs into the skin of the man's back. In this way, it is reported, he succeeded in injecting sufficient sustenance to maintain life.

Ten ounces of fatty foods, nearly an equal amount of sugar, other carbohydrates, and six ounces of protein were fed to the patient in this novel manner.

Zoologists Seek to Save Whale from Extinction

WHALES are in danger of extinction, according to Dr. A. Brazier Howell, zoologist at Johns Hopkins University. Modern power boats and improved equipment, he points out, have increased the catch until nearly 30,000 of the oil-producing mammals are now killed each year, whereas, during the entire forty years when Yankee whaling was at its peak, not more than 100,000 whales were killed.

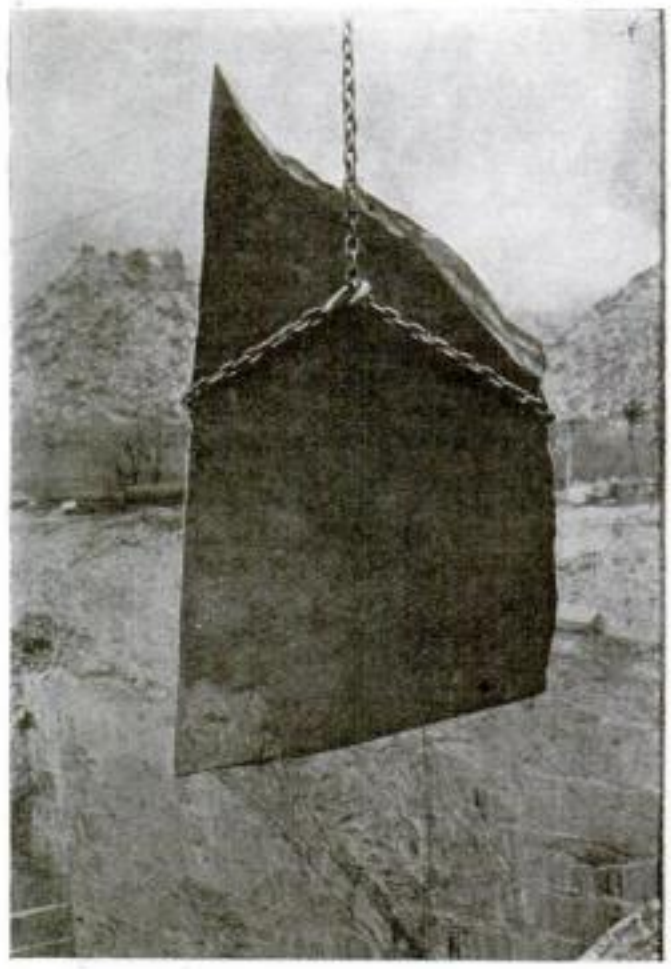
Except for the finest grade of lubricating oil, such as is used in scientific instruments, whale oil is not needed. Dr. Howell believes substitutes should be found in order to decrease the annual kill. He is secretary of the American Society of Mammalogists, the aim of which is international action to save the whale.

Six-Ton Slate Block Hoisted from Quarry

HOISTED like a fish at the end of a long line, a six-ton block of slate recently was removed from the bottom of an 800-foot quarry in Pennsylvania. Subsequently the slate was cut up into small pieces for roofing. Workmen with thin, broad wedges split out the layers.

So great is the waste in preparing slate for market that seventy-five percent of the product brought from the ground has to be thrown away. The mountains of material visible behind the slate block in the picture are part of the waste discarded during operations of the quarry.

About half the slate quarried in the United States comes from Pennsylvania.



The huge six-ton slate block lifted 800 feet out of a large Pennsylvania quarry. In the distance may be seen great mountains of waste from the quarry.

Walnut Trees Kill Plants

AS EVERY woodsman knows, vegetation will not grow under walnut trees. A chemical poison exuded by the walnut tree is responsible, Everett F. Davis, of the Virginia Agricultural Experiment Station, has discovered. He succeeded in isolating this substance, which he has named "juglone."

Researchers Baffled by Six Radio Mysteries

RADIO researchers are looking for answers to numerous questions, among them ones such as:

Is there any difference between transmission of radio waves in the direction of the earth's rotation and the other way about? Some recent Marconi experiments indicate that there is. If so, why?

Does it make any difference to the radio waves whether they travel along or across the earth's magnetic field?

Why is transmission over water easier in some parts of the world than in others?

Is there a limit in wave length beyond which transmission over land is practically the same as over water?

What causes the ionization of air to form the Kennelly-Heaviside layer? And do radio waves above a certain frequency penetrate that layer and then fail to return to earth?

Who can answer these questions?

Tear Gas Warns of Poison

THE inclusion of tear gas in poisonous fumigation used to kill microbes and rodents on vessels is suggested by the U. S. Public Health Service. A slight amount of this gas, the Service points out, will serve as a warning to persons who may be in the holds and thus prevent fatalities. Experiments have shown that small amounts of tear gas are harmless and will give warning in time to allow escape from the poisonous products used in the fumigation of vessels.

Sandbags to Strengthen Wrists of Pianists

PIANISTS can play better if they suspend sandbag weights from their wrists during practice periods. This is the belief of Huston Ray, a musician of Los Angeles, Calif., who has devised a unique aid to piano students in the form of six-pound leather bags weighted with sand.

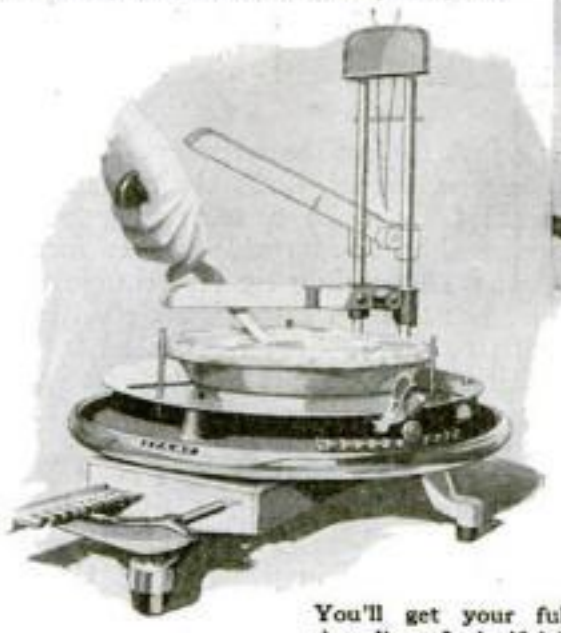
The principle, he says, is the same as that employed by the Greeks, who carried weights while practicing jumping for their Olympic games. The removal of the sandbags, Ray declares, has the effect of "giving wings to the fingers," while their continued use strengthens the wrists and fingers, enabling the player to attain more power in the fortissimo bars of a composition.

Huston Ray puts sandbags on pupil's wrists to give strength in hitting the piano keys.

Divider Slices Pies into Cuts of Equal Size

TAKING the guesswork out of cutting pie and cake, a new device assures restaurant patrons that they will receive pieces of equal size, says its maker.

The pie or cake to be cut is held firmly upon a turntable by adjustable fingers. After an index lever governing the number of cuts has been set, a knife slipped into the blade guide slices out the pieces, a lever moving the turntable ahead after each movement of the knife. The index lever permits the pastry to be divided into from three to thirty-four equal cuts.



You'll get your full size slice of pie if it's cut by this machine.

If it is desired to change the bulk of the pieces at any time, the index lever can be set to increase or decrease their size by altering the number of cuts. Pastries from seven to twelve inches in diameter, and up to eight inches in height, are handled by the machine.

The maker adds that the device satisfies customers because all get equal cuts and, as the moving parts are simple, the machine is easy to keep clean.

Want White Hair? Then Use X-Ray "Bleach"

IS YOUR hair turning prematurely gray? Then it's a pretty safe guess that one of your parents had hair of a color different from yours. At least, that is the conclusion reached by zoologists of the University of Pittsburgh after a series of tests they conducted to ascertain why the hair of some persons turns gray or white sooner than that of others.

The experiments were made with a number of mice. Exposing them to X-rays, which will turn hair permanently white, the zoologist found that young mice with coats of the same color as those of both their parents showed the greatest resistance against turning white, while those with parents of different colors were "bleached" in short order.

Paints "Einstein" Pictures of "Energy" in Art

ART paintings that display moving, animated figures, to the accompaniment of a grinding noise of machinery, are the invention of Alexander Archipenko, Ukrainian artist. His new form of art, which he styles "Archipentura," was exhibited recently in New York.

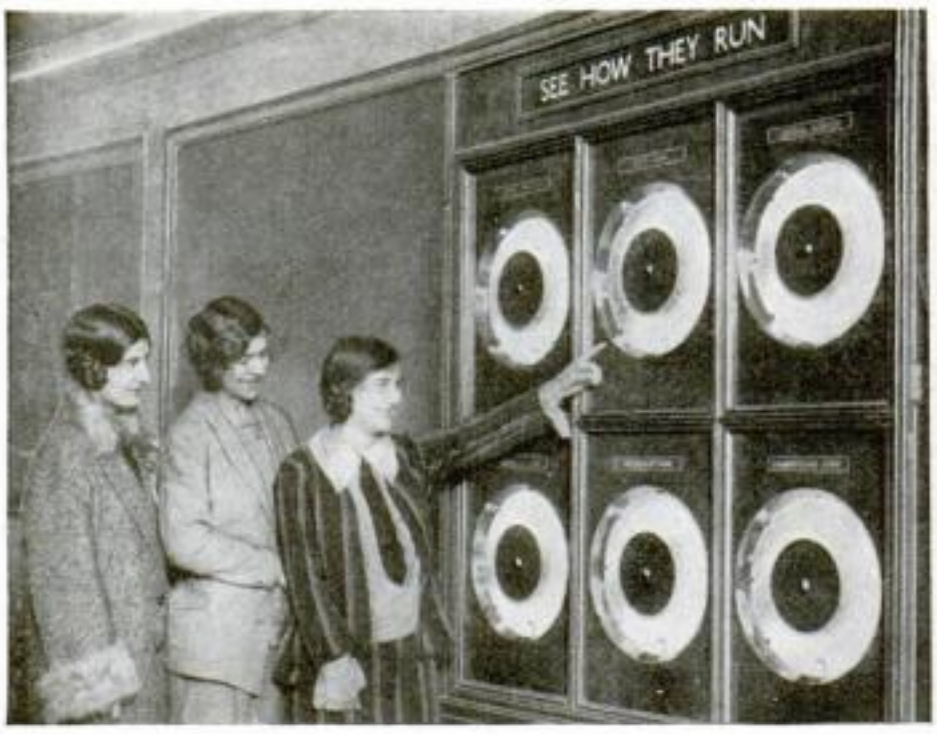
A special machine, used to display his unique creations, consists of 110 horizontal rollers, each bearing a strip of painted canvas, and arranged one above another so that a whole composite picture results. When the machinery commences to whir, the rollers turn and new forms and colors appear.

The invention, Archipenko says, offers new possibilities of depicting energy in art. However, the paintings are laborious to make. It takes 200 hours to reproduce the myriad small studies required for the canvas. A machine for home use might cost $50,000; so far there is only one in existence.

Spectators saw changing scenes merge into one another in a demonstration of one of Archipenko's unique canvases. First appeared colors spreading as oil on water; then followed in quick succession an Indian blanket pattern, a female figure waving an arm, a lavender cone, another figure whose costume changed color, a checkerboard, a vase of flowers on a table, and a panel reading "Dedicated to T. Edison and A. Einstein."

Sees "Magic" in Medicine

WITH all the advance made by science, medical practice still deals largely in magic, in the opinion of Prof. Lynn Thorndike, noted historian of Columbia University. "A confidence game is practiced on the patient, who must be cheered and distracted," he says. Sending a man to Florida or out to play golf is on a par with the ancient practices of the medicine men, but both inspire confidence that the patient is going to get well, Thorndike declares.



Dials Show Time-Table of Trains at a Glance

PERSONS who have difficulty in figuring out the intricacies of a time-table will be interested in an automatic device which is a unique feature of the Piccadilly Underground Station, recently opened in London. A complete time-table is always before the eyes of passengers waiting for subway trains.

Six dials record not only the time trains on the various lines are to arrive, but also their actual position at the moment. If a train is late, its progress along the rails can be followed by those in the waiting-room.

The new Piccadilly station, the heart of the London tubes, was designed to accommodate 50,000,000 passengers annually; 1,600 trains pass through it every day, on the average.

In the picture above, one girl is showing two others how to "see how they run" as recorded on the station's dials.

Underground Gold Vault Rivals Hugo's Fiction

THE fiction of Victor Hugo and Eugene Sue, in which thrilling and mysterious doings in the maze of sewers and tunnels underneath Paris are described, has been rivaled by fact. The Bank of France, after three years of work by nearly 1,500 men, has completed construction of a subterranean hiding place for the $1,000,000,000 gold reserve of France which, for imagination of design and ingenuity of construction, surpasses anything conceived by those famous romancers.

Two hundred feet underground the gold chamber containing the secret vaults covers an area of two and a half acres. It is separated from the street surface by forty feet of water and fifty feet of rock, the latter forming an arch over the water, through which a secret system conveys the air supply. In the event of war or revolution, more than 1,000 men, safe from bombs and gas attacks, could be accommodated in the spacious underground rooms to guard the nation's treasure, even though the bank itself should be demolished overhead.

Food is kept constantly on hand for just such an emergency. There are kitchens, stoves, beds, chairs, and other articles to make a temporary sojourn reasonably comfortable for a force of men. Descending by electric elevators, one has to pass through six steel towers with revolving doors, operated by electricity, to reach the vaults. In case of serious trouble, the elevator shafts can be flooded.

The walls and doors are of steel and concrete, twenty feet thick. But if, despite all these precautions, an enemy should succeed in penetrating, there are ultimate means of defending the gold reserve which remain the secret of the French government.

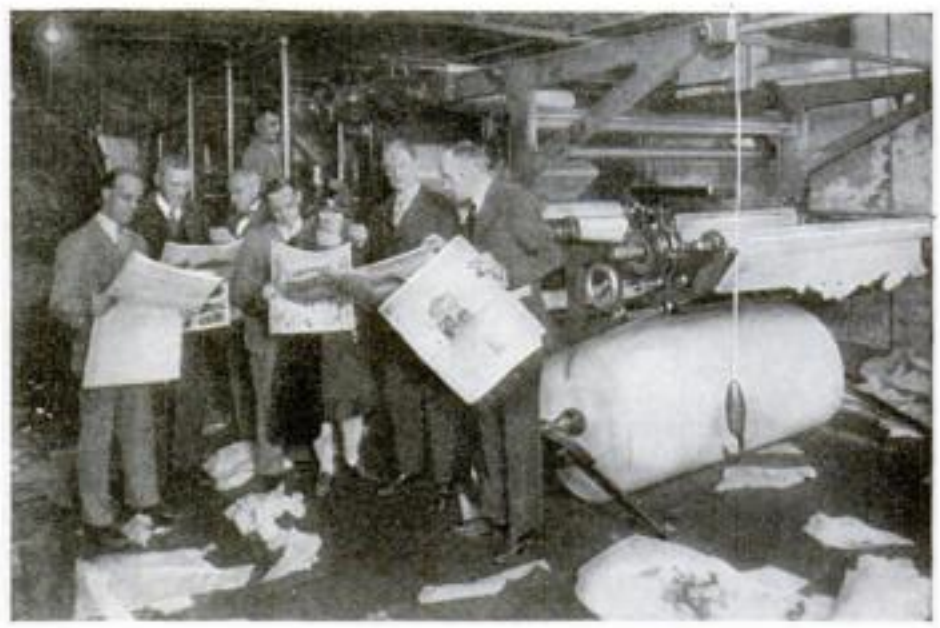
Folding Bicycle Carried Like a Typewriter

A COLLAPSIBLE bicycle which can be ridden to a station, folded up, and taken on a train in a small suitcase has been brought out by a French bicycle maker. He expects it to be popular among city dwellers who have no space in their apartments to store a full-sized machine, but would like to ride a bicycle to work or to and from the station when traveling. Commuters also are expected to find special use for the bicycle—they can ride on it to the railroad station in the morning, check it, and pedal home again in the evening.

In spite of the small size of the wheels, it is said the machine is geared sufficiently high to attain a speed of twenty miles an hour on level ground, and that it is constructed strong enough to support a man of more than the average weight.

A traveler can pack this tiny collapsible bicycle into a small suitcase and carry it with him no matter where he goes.

Newspapers from Cornstalks



Editors in Danville, Ill., examine the first newspapers printed on cornstalk-pulp paper.

NEWSPAPERS, magazines, and a book, recently made from cornstalks, represent the latest step in utilizing waste products of the farm. In the pressroom of a newspaper plant at Danville, Ill., cornstalk paper was tested for the first time in actual competition with wood-pulp paper and the results are said to have proved satisfactory. Further tests are being made, to determine whether large-scale production of the cornstalk-pulp paper will prove economical.

The newsprint made from cornstalks is said to look exactly like wood-pulp paper, but to be of stronger texture and to be very white, taking ink clearly.

The first book printed on paper made from what has been a waste product of farms in the past is, appropriately, a volume on "Farm Products in Industry," by George M. Rommel, who recently made a survey of farm waste for the U. S. Department of Agriculture.

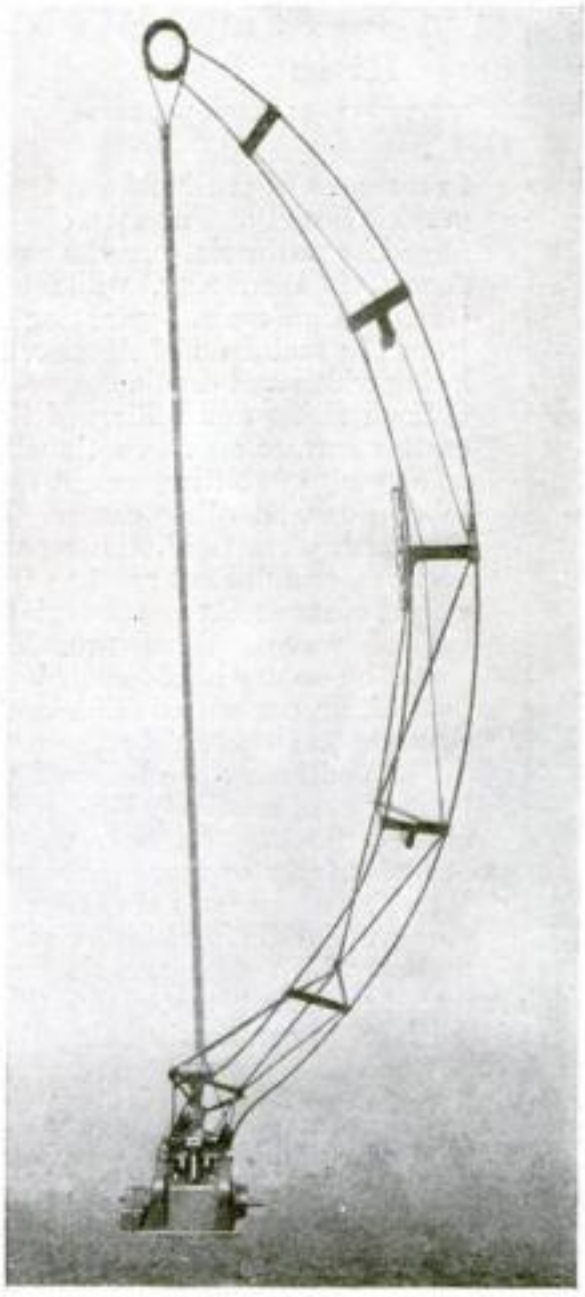
The Same Old Money, but in Smaller Paper Bills

ALL of us, no matter how blessed with this world's goods, soon will have less money. The new currency to be put in circulation this year will measure six and five sixteenths by two and eleven sixteenths inches. Our present bills measure seven and three eighths by three and one eighth inches.

On the whole, the smaller money will present the same general appearance as that now in use. One difference will be a new distinctive paper which the Treasury Department announces will have greater endurance than the old. A small amount of silk is now used in our bills. This feature will be continued, but instead of being concentrated in rows, the silk threads will be distributed over each bill.

Information Available

POPULAR SCIENCE MONTHLY is glad to supply, whenever possible, the names and addresses of manufacturers of devices mentioned in its pages. Address all requests to the Information Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.



How the new safety gate appears when up. It drops automatically as train nears.

Mail Carrier Has "Circled Earth" Seven Times

WALKING a sufficient number of miles within the city limits of Baltimore, Md., to have circled the globe seven times and have 4,000 miles left over for good measure is the remarkable record of a mail carrier who has just decided that his feet need a rest and has retired from the postal service.

John E. Ruark, the Maryland "globe-trotter" in question, marched an average of fifteen miles a day, 306 days in the year, for thirty-nine years, making a total of 179,010 miles. The earth's circumference, in round numbers, is twenty-five thousand miles.

In this long period of service, Ruark has carried about 24,000,000 pieces of mail, or thirty letters for each one of the 800,000 men, women, and children who now inhabit Baltimore.

Pedals 175,000 Miles on Bicycles in 20 Years

WEARING out three bicycles in twenty years, Charles A. Stoops, former Chief of Police at Easton, Md., has pedaled 175,000 miles, more than most motorists would drive a car in the same length of time. Statistics show that the average automobile owner drives approximately 8,000 miles a year. Sixty-seven years old, Stoops covered 8,780 miles last year and, although his earlier bicycles did not have cyclometers, he is sure his average mileage in the preceding years was higher.

Crashless Crossing Gate Bends Like a Bow

A NEW safety railway crossing gate, shaped like a violin bow, is designed to prevent motorists crashing through onto the track, as occasionally happens with ordinary wooden gates. The "string" of the bow is composed of two tightly stretched steel cables supported by a frame of spring steel forming the curved bow. Between the "string" and the "bow" is a space of five or six feet to allow the cables to give when struck by moving automobiles. The cables face the motorist as he approaches the crossing.

When the gate is lowered, a loop at the end of the bow drops over the post of a hydraulic snubber. This snubber is capable of moving back six feet. The impact of a colliding vehicle, after bending the bow, forces back the snubber, thus easing the blow. The device is said to have stopped a 4,000-pound car, traveling thirty miles an hour, within three and a half feet without damaging either the machine or the gate.

The safety of motorists who find themselves trapped between lowered gates is also provided for in the new barrier. While the locking device on the snubber post prevents the closed gate from opening toward the track, it does not interfere with opening it in the opposite direction. Thus the trapped driver can force the gate with the nose of his car.

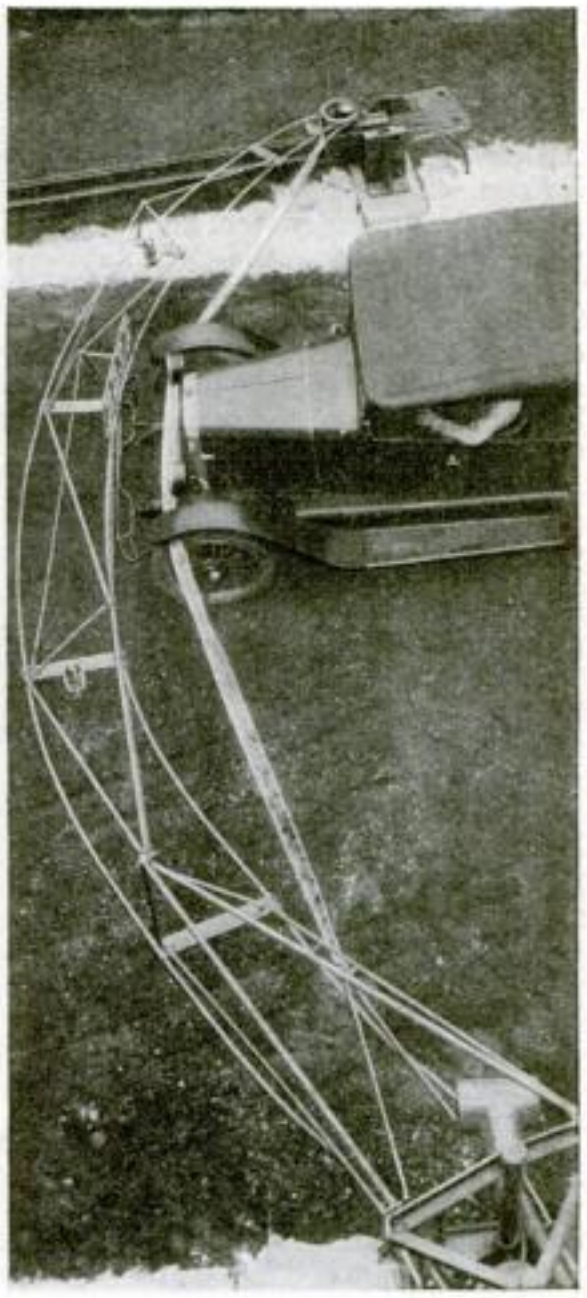
The operation of the gate is entirely automatic. Electric circuits keep it closed as long as a train is in the danger zone, thus preventing motorists from rushing on the track in front of a second train after the first has passed.

The weight of the gate is so evenly balanced that it can descend upon an automobile without damaging the top.

A Riveter for 50 Years, He Claims the Record

IF YOUR nerves jump at the staccato noise of the riveters at work on a new steel building, you can appreciate something of the job of Edward Fay, of New York City, who listens to that music almost every day. He has been a riveter for fifty years. Fay, who is sixty-five years old, claims the distinction of being the oldest riveter still on the job. His co-worker, F. Smith, has held rivets for Fay for the last thirty years.

Edward Fay (right), veteran riveter, and his partner who has held rivets for him 30 years.



When a car hits the gate, the steel "string" of the bow gives, and a snubber lessens shock.

Smallest Torch Reveals Microscopic Life

THE world's tiniest torch—a light so small that it will illuminate the interior of a single living cell under a microscope—is proving an aid to laboratory investigation at the University of Pittsburgh. The instrument consists of two pencil-shaped pieces of quartz put together like pincers with the points, which were drawn down finer than those of needles, coming together.

As a result of quartz's unusual affinity for light, a violet ray introduced at the large ends of the "pincers'" legs will be carried to the small ends, which then are used to light infinitesimally small fragments of matter placed under the microscope for examination.

With the new device, called the "microradiator," investigators are enabled to penetrate into the heart of single cells and study processes in the growth of living organisms.

Gas Masks to Be Used in Fight on Hay Fever

GERMAN scientists have adapted the gas mask of World War fame to use in the battle against flower pollens that cause hay fever and which are believed responsible for asthma. The new mask filters the pollen out of the air just as the war mask did poisonous gas.

How fine is this filtering process may be realized from the fact that the grains of some of the troublesome pollen are less than a millionth of an inch in diameter.

Aerial Camera Snaps New Canyon Bridge

HOW a man-made spider's web appears to a man-made bird is revealed in a remarkable photograph taken recently from an airplane flying above the Marble Gorge of the Grand Canyon of the Colorado, in the northwestern part of Arizona. It shows the steel span of the new highway bridge being completed across the Gorge below Lee's Ferry.

In a region of untamed scenic grandeur, 135 miles from the nearest town, this span, 616 feet long, has been erected at a cost of $330,000 to open up hitherto inaccessible regions in Arizona and Utah for tourist travel. The bridge reaches out over the canyon with a sheer drop under it of nearly 500 feet to the waters of the swirling Colorado River. Some of the tremendous obstacles which engineers were forced to overcome in its construction were related not long ago in POPULAR SCIENCE MONTHLY.

A magnificent photograph of the new highway bridge across Marble Gorge, Grand Canyon, taken from an airplane flying above. The bridge is almost five hundred feet above the water.

Lower California Is Rising from Sea

LOWER California is steadily rising from the sea, according to a report of the National Geographic Society. The area of the fingerlike peninsula, surveys have shown, is increasing, while the Gulf of California, separating it from the mainland of Mexico, is losing width and depth.

Such rising and falling of the earth's surface go on continually as a result of shifting weight due to erosion and other causes. If the earth were rigid, the report declares, and did not react to the weight of ice sheets and the grinding of waves, there probably would be no dry land today, but, instead, an ocean two miles deep covering the whole globe.

The continents are believed to be masses of relatively light solid matter, floating on hot, glassy material forty or more miles below. The ocean beds are believed to be underlaid by heavier solid matter which does not float as high as the continent material. The earth's surface is constantly being disturbed, so it must bulge in one place and sink in another to regain its balance, somewhat as a tight-rope walker flings out an arm or draws it in to restore equilibrium.

The Grand Canyon of the Colorado is believed to have been formed by a bulging movement that caused land to lift gradually against the flowing river. Thus is the great depth of the Canyon accounted for. Other parts of the earth are known to be rising or sinking. Southern Denmark drops an inch every twenty-five years, while portions of the upper Baltic region rise a foot every thirty years.

Detects Secret Message by Shading of the Ink

IF EVER you have occasion to include a secret message in a letter be sure to write the entire missive with a well-filled fountain pen and not with an ordinary pen which has to be dipped into ink. A British handwriting expert discovered the other day that part of a letter consisted of a secret message by studying the manner in which the writer had replenished his pen.

The letter was written from beginning to end in plain English and contained no code symbols nor cryptic language of any sort. But the expert saw that a certain paragraph had been copied, while the rest of the missive was the writer's own spontaneous expression.

When we write down our own thoughts, we unconsciously dip our pen at the end of each sentence, the first letter of the new sentence becoming heavier as a result. But when we copy, the pauses and blacker letters occur more frequently. By recognizing this fine distinction in shading, the handwriting expert was enabled to locate the secret message, which he finally decoded.

Gunny Sacks from Banana Trees

BANANA trees may yield fibers to take the place of jute in the manufacture of gunny sacks used to carry produce all over the world, if hopes of Brazilian textile men are realized. An invention for utilizing the tree fibers for this purpose was described recently at Rio de Janeiro.

Brazil imports nearly $6,000,000 worth of jute every year. It is used mainly in the shipping of coffee. The plant from which jute, sometimes called "Calcutta hemp," is obtained is grown chiefly in India and, to a limited extent, in China, Formosa, and southern Japan. Partly successful attempts have been made to grow it in the South Atlantic and Gulf sections of the United States.

Attempts to naturalize it elsewhere have failed, so the supply is limited and a substitute in the form of tree fibers would mean a great saving to shippers.

A Trainload of Gasoline Goes Up in Smoke

A $60,000 pillar of smoke darkened the sky at Zyba, Kansas, following a recent railroad wreck in which twenty-seven tank cars, filled with gasoline, jumped the track, piled in a tangle, and burst into flames. All of the valuable cargo, on its way north from the oil fields of Oklahoma, was destroyed by the fire.

The photograph below, taken when the fire was at its height, shows the immense cloud of dense black smoke that rose from the burning gasoline.

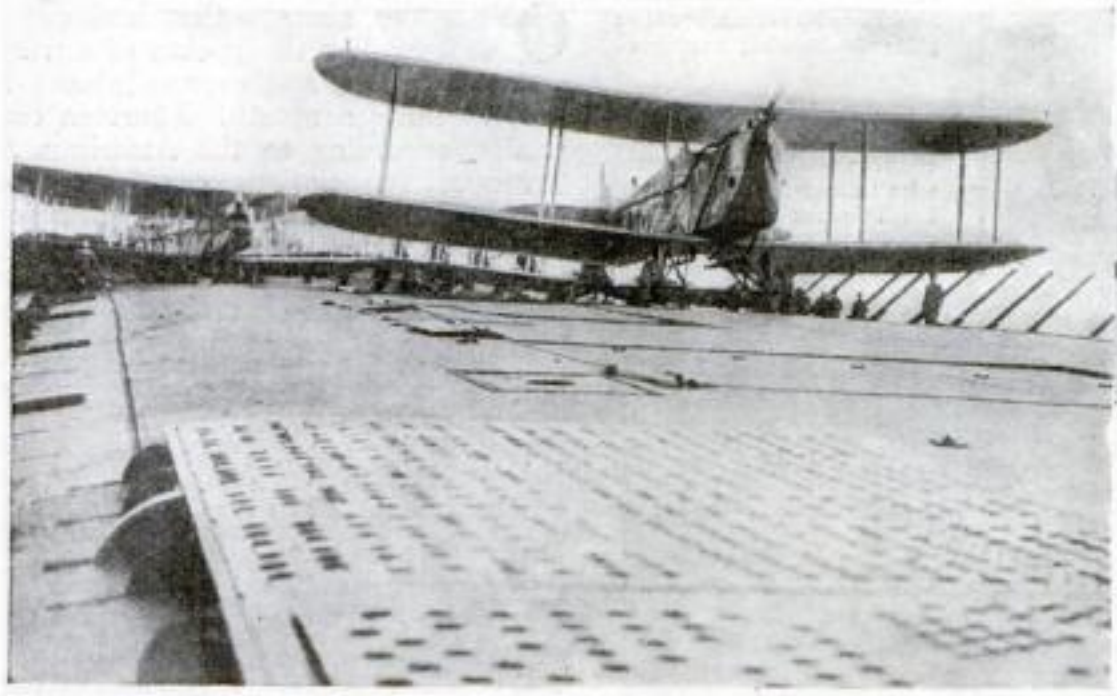
Thousands of gallons of gasoline burning. This spectacular fire followed the wrecking of a train of twenty-seven tank cars on the Kansas prairies.

Light from Tumbling Suns Arrives in 800 Years

IN THE year 2729, some astronomer will be able to ascertain whether two giant suns, which were seen rolling around each other in space a few weeks ago, actually existed in 1929, when they were observed for the first time, or whether they passed out of the universe centuries before. The light of these two stars, seen recently by astronomers at the Mount Wilson Observatory, in California, takes 800 years to reach the earth, so there is no way of telling whether they still exist.

What the astronomers did establish, however, was that they tumbled about each other, that one was more than five times as large as our sun, but weighed less than twice as much; that the other was three times the sun's size, but was six times as heavy; and that they were a mere 9,000,000 miles apart, which is a rather neighborly distance as such matters go in space, for we are separated from our sun by about 90,000,000 miles.

War Birds Flit from Floating Nest Built Like Dovecote



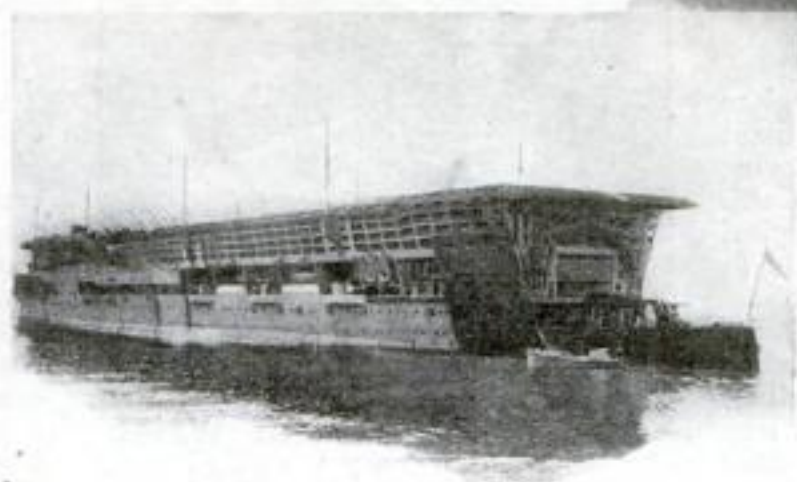
A British fighting plane rising from deck of airplane carrier *Furious*. In foreground is wind screen which can be raised.

Officers in the control pit signal the sea flyers when to take off. Special devices prevent planes from running overboard when landing in storms.

ONE of the great floating nests for war birds is the British airplane carrier *Furious*, which is equipped with many devices to increase the efficiency of machines flying at sea. The "roof" of the vessel forms the broad expanse for the oceanic flying field. From it, elevators lower and raise the planes to and from hangars and repair shops provided to house them when not in use.

When the Blackburn-Dart war planes, used to train naval pilots on the *Furious*, swoop to a landing their wings are folded back by mechanics before they are placed upon the elevators, so they will occupy less space in the vessel's interior.

To prevent planes from running off edges of the deck, when making a landing in bad weather, a heavy fence has been built around the far end of the landing platform. This guardrail is slanted outward at an angle so it can stop the



Towering in tiers of hangars like a dovecote, the plane carrier is truly a huge floating nest.

machines without damaging them. Heavy metal screens, swung up to break the force of the wind in gusty weather, shelter parts of the deck and give added protection to landing pilots.

During practice maneuvers, the machines take off one after the other, each departing at a signal from officers in the control pit at the end of the runway, just as air liners take flight under direction of an officer in an airport tower. In charge of a flight commander, the pilots circle out over the sea in wedge-like formations of six, often flying hundreds of miles before spiraling down to a landing on the mother ship. The complete crew of this marine flying field includes 890 officers and men.

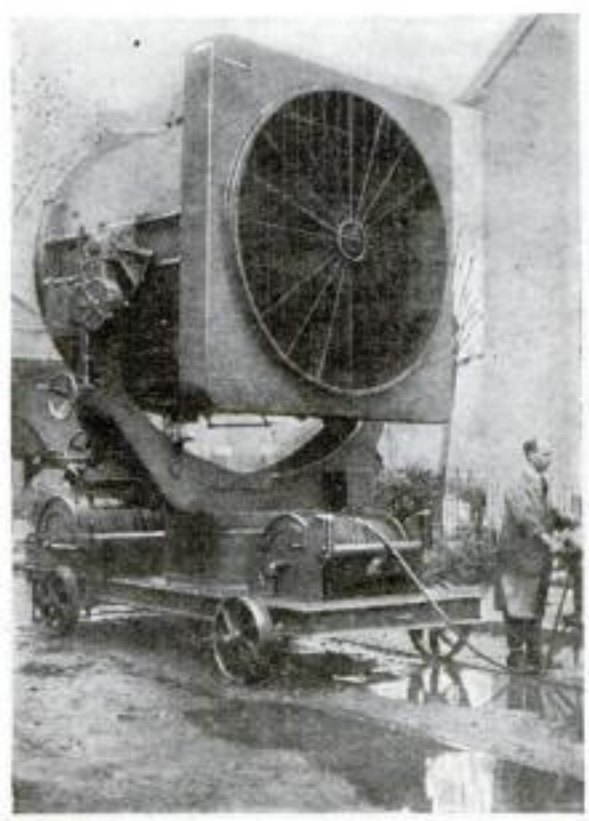
Salamanders Grow Eyes

"EYELESS" salamanders, born in deep caves, develop eyes when reared in the light, according to G. K. Noble and Sarah H. Pope, of the American Museum of Natural History. The organs of vision, apparently lost, are merely dormant, they found.

Huge Searchlight's Beam Will Guide Air Liners

YOU can stand upright within an immense searchlight recently completed in England for use at the famous Croydon Airport. It is seven feet six inches in diameter and, mounted on its platform, stands fourteen feet high.

The operator of the huge night guide for passenger air liners sits upon a seat above the platform and directs the beam of light by means of cranks and gears. The distance the 3,000,000,000-candle-power light, said to be the most powerful ever built, penetrates through the darkness will be determined when the searchlight is put into regular operation.



A man can stand within the reflector of this giant searchlight to guide English air liners.

Finds Babies Are Normal Despite Parents' Ages

THE ages of parents at the time of a baby's birth have no bearing upon the normality or lack of it in the individual, nor does it make any difference whether one is oldest or youngest in a large family, Dr. Madge Thurlow Macklin, of the University of Western Ontario Medical School, recently reported as the result of extensive observation of 111 pairs of twins.

If heredity caused defects in one twin it would operate the same way with the other of the pair, but defective individuals often have normal twin brothers or sisters, she found. Dr. Macklin also declared she had exploded the theory that worry or shock to the mother before birth has any effect upon the offspring.

Whale Eats Millions of Shrimp for Lunch

LESS than two dozen shrimp are needed to make you a satisfying salad, but the whale, largest animal alive, which curiously enough dotes on these little creatures, eats millions of them alive for his daily luncheon.

A group of scientists just returned to England from an expedition to the Antarctic, now the greatest whaling ground, reported that the huge sea beasts there live almost exclusively on a variety of very small shrimp, which they swallow alive by millions.

The shrimp, in turn, subsist on diatoms, tiny plants on the ocean's surface.

Amidst a tropical setting of cooling palms, hot irons are used to smooth the sun-defying "ice" over which Hollywood's screen beauties glide in bathing costumes.

A. R. Maas pouring boiling chemicals over a meshed wire framework to "freeze" his summer skating pond.

Bathing Beauties Skate on Sunproof "Ice"

SKATING in bathing suits on a glaze of chemical ice that the sun cannot melt is the latest sport in the moving picture colony at Hollywood, Calif. Surrounded by palms and other tropical foliage, the skaters glide and circle in the joyous pastime of colder climates.

After they have been in action for a time, the caretaker of the unique skating pond appears with a large hot flatiron and smooths the ice as one would iron a towel or a tablecloth. This is done periodically to remove rough spots the sharp skate blades cut in the hard, polished surface. If the fad spreads, "ice ironing" may be a vocation of the future.

The synthetic "ice' was developed and laid by Arthur R. Maas, a chemical engineer of Los Angeles. A framework covered with heavy screen wire is constructed as a first step. Over this the chemicals, dipped from a caldron with a long-handled dipper, are slowly poured. They cool and harden quickly, forming a surface that appears like real ice, although it is unaffected by a blazing midday sun.

Similar skating rinks of synthetic ice are used in Germany, as was reported in a recent issue of POPULAR SCIENCE MONTHLY. The imitation ice used for the German rinks, however, is formed from solid chemicals sprinkled over a wooden floor. They harden into a smooth surface on which the skates have little effect.

Double-Walled Pot Keeps Flowers Watered

A DOUBLE-WALLED flowerpot, the inner part porous and the outer waterproof, with the two united at the top by a flat rim, was described recently by Dr. J. Dean Wilson, of the Ohio Agricultural Experiment Station, who said that extensive experiments proved its usefulness in automatically irrigating plants growing in it.

Infra-red light, composed of rays longer than the red of the visible spectrum, have no effect upon leaves, in the opinion of Dr. J. D. Sayre, of the same experiment station, but ultra-violet light, the invisible rays at the short-ray end of the spectrum, have a stimulating effect.

One Twist of the Wrist Sprinkles 10 Acres

LIKE turtles drawing in their heads and closing their shells, automatic sprinklers installed recently in the sheep meadow at Central Park, New York City, disappear into the ground and pull tight coverings over themselves to give the meadow a smooth surface when the water is shut off. By turning a single valve, park workers can sprinkle the ten-acre meadow.

John A. Brooks, inventor of the unusual irrigating system, was present when the sprinklers were tried out for the first time to demonstrate that their action is entirely automatic.

When the water is turned on, the spray heads rise above the ground. When the water is shut off, they drop into underground casings protected by covers and remain in this position until used again.

Chicago "Hub" for Planes Flying 565,406 Miles

OVER the airways that lead out of Chicago like the spokes of a wheel, mail, passenger, and express planes fly 565,406 miles a month. Fourteen companies, according to the American Air Transport Association, operate lines out of this one city. Most of this mileage is rolled up by mail planes, but the passenger service taking off from Chicago fields totals 106,000 miles a month.

An innovation in passenger plane equipment will be installed as part of the air-rail service of the Transcontinental Air Transport Company this spring. Radio telephones, similar to those used on the London-Paris air liners, will provide direct communication between the pilot and the ground at all times, says C. M. Keyes, president of the company.

Tiny Camera Photographs Inside of Stomach

A TINY camera, which takes sixteen pictures of the inside of the stomach on films with a total area less than that of a postage stamp, was swallowed recently by a convict at Sing Sing Prison, New York, in a demonstration before a meeting of medical men. The instrument, known as a gastro-camera, was designed by Franz G. Bach, of Vienna, Austria, to aid physicians in diagnosing stomach disorders. The minute films are capable of great enlargement, so that the exact location and character of gastric ulcers can be determined by surgeons before operating.

Sixteen lenses, in two tiers, encircle the camera, which is like a cylinder about two inches long and half an inch in diameter. The sixteen negatives give a complete picture of the inside of the stomach. A single filament wire, inclosed in quartz glass, furnishes the illumination. This portion of the instrument is inclosed in a rubber case, perforated so light is thrown in the same direction the lenses point. The rubber tube, which extends from the patient's mouth, carries current to this lamp from a storage battery.

Patients go without food just before pictures are taken and air is pumped into the stomach before the camera is swallowed. The whole operation of taking the internal photographs is said to require but a few seconds.

Turning on the new sprinklers which rise automatically from ground to water the ten-acre sheep meadow in Central Park, New York. John A. Brooks (right), is inventor of the disappearing sprays.

Church Manufactures Its Stained Glass Windows

STAINED glass windows which beautified medieval cathedrals, though exquisite in coloring and design, were not meant primarily for decorations, but rather were intended to serve the purpose of pictured story books at a time when illustration was confined principally to illuminated initials in manuscripts. These windows graphically told the worshipers of the lives of the saints and other religious incidents the church wished to impress upon them.

Reverting to this olden practice, the builders of the great Protestant Episcopal Cathedral on Mount St. Albans, at Washington, D. C., will install an extended series of beautifully colored windows which will relate virtually the entire story of Christianity and the influence it has exerted on mankind.

Designers of the Cathedral also are following another example from medieval times, when the church was the mother and chief patroness of the arts. They have established their own stained glass plant at Philadelphia, where, under supervision of noted artists and experts, the great rose windows and other glass adornments for the Cathedral are being made.

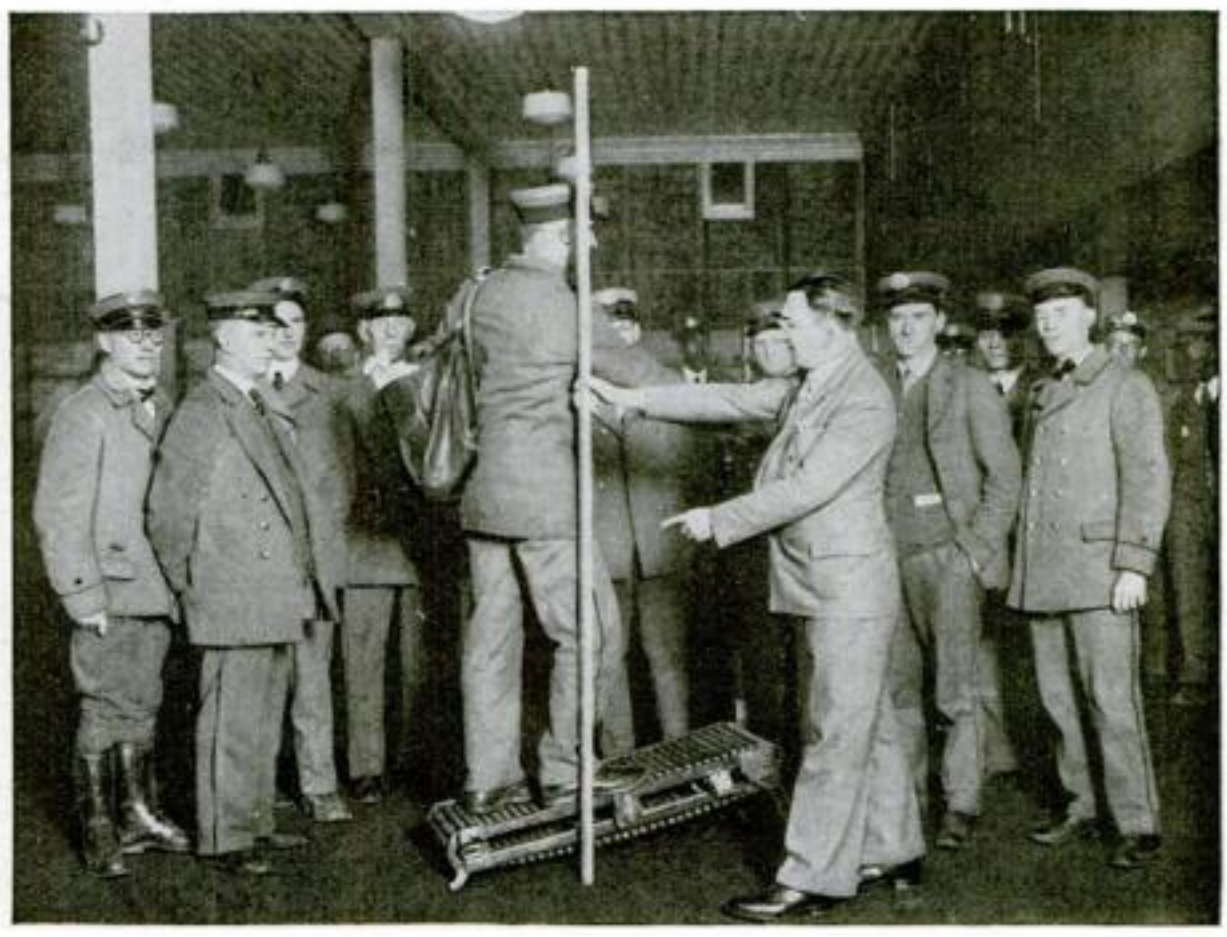
Many Uses Combined in One Watering Can

A NOVEL watering can designed for half a dozen uses is now on the market. A spout at one side equips it to fill automobile radiators. A two-by-eight-inch perforated mouth on the other side is a sprinkler for gardens and lawns. It helps in washing automobiles, too, the maker says, as it furnishes a steady, gentle shower without splashing.

Applying liquid fertilizer to plants is another job for which the device was planned. If insects attack vines or plants, it can be used to spray insecticide through the perforated mouth, it is said.

When it is not engaged in any of these tasks, or in dampening golf greens, the can goes fishing in the capacity of a minnow pail.

You can sprinkle the garden, spray insects, or wash autos with this novel watering can designed for many outdoor tasks.



Treadmill Prancing Trains Postmen to Walk

TEACHING postmen how to walk may sound paradoxical, but teaching them to walk hygienically is a positive boon to them and to the public they serve, according to a Chicago foot specialist, Dr. J. C. Rintelen, who recently gave lessons to sixty letter carriers in Norfolk, Va.

Using a treadmill, the postmen were instructed to "keep the feet straight ahead—don't toe out—take brisk, snappy steps—swing the arms freely—stand erect." They also were shown the correct posture for rapid walking.

Jointed Handle Is Aid in Stamping

BY PROVIDING play between the handle and mounting, a rubber joint increases the ease with which a new stamp can be used. It allows the handle to be held at different angles without marring the impression.

In the ordinary rubber stamp, with rigid handle, care must be exercised to keep the stamp horizontal or its impression will be blurred or incomplete. The improved device, the maker says, speeds up the work of stamping.

Canadians Will Use Peat To Reduce Coal Bills

PEAT fuel will be prepared for the markets of Ottawa and Montreal, Canada, in a government plant at Alfred, Ont., which is practically automatic. It will operate twenty-two hours a day and turn out 20,000 tons of peat "bricks" during the winter season of 100 days.

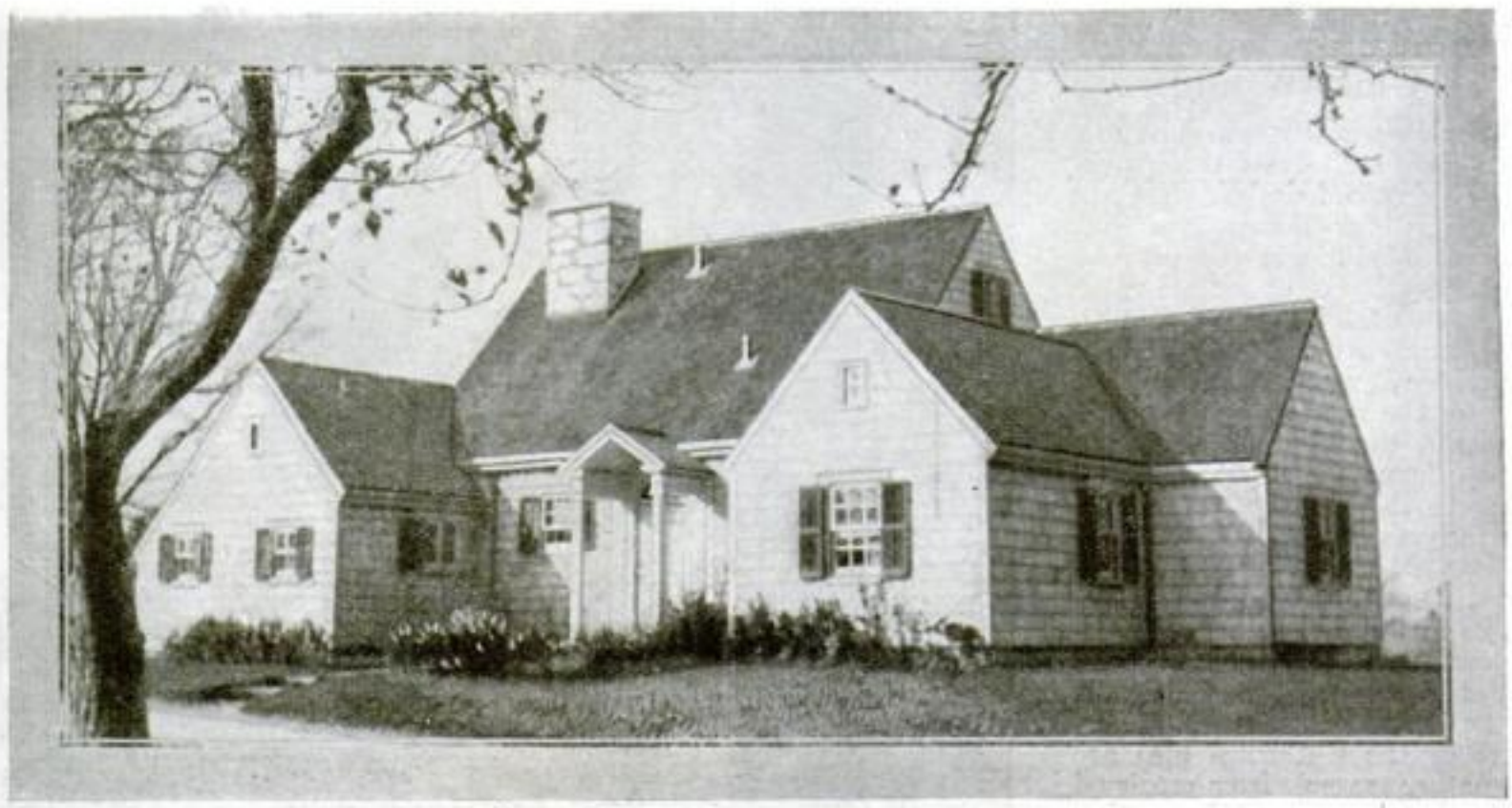
Except wood, peat is the only natural fuel found in quantities in the provinces of Ontario and Quebec. The Department of Mines of Canada has surveyed, mapped, and sampled more than 250,000 acres of peat bogs in the two provinces. It estimates that these bogs will yield peat in excess of 250,000,000 tons, thus reducing the amount of coal that must be imported.

Snake Bites Killed 27 in U. S. in a Year

TWENTY-SEVEN persons died of snake bite in the United States in 1928, according to R. H. Hutchinson and R. E. Stadelman, of the Antivenin Institute of America.

Five hundred and seventy persons were victims of different varieties of poisonous serpents. Of these 159 were bitten by copperheads in twenty-one states, thirty-eight by cottonmouth moccasins, seventeen by the pygmy rattlesnake, seventeen by the swamp rattler; ninety-five by the true rattlesnakes of the diamond-back, or Texas, variety; forty by timber rattlers, thirty-eight by prairie rattlers, twenty-seven by Pacific rattlers, eleven by the eastern diamond-back, and four by desert "sidewinders."

Four hundred and one of those bitten were treated with antivenin serum, which neutralizes the "venin" or poison in snake venom, and only eleven died; of the 169 cases untreated, sixteen died.



Carefully insulated against extremes of wind and weather, this rambling Connecticut house on Long Island Sound stays comfortable through the year.

Locking Out *the* Heat *and* Cold

A Home Builder Finds Improved Insulation Soon Pays for Itself in Comfort and Lower Fuel Bills

By WILLIAM DEWEY FOSTER

IF YOU are planning to build a home of your own, you'll be interested in this article, the first of a series by distinguished American experts, based on the actual experiences of house builders who have solved the problems that every prospective home owner must face.—The Editor.

WITHOUT comfort, no matter how economically it may be built or operated, a home becomes a mere shelter from the elements. In recent years, American builders have been striving more and more to make houses livable and healthy. And in accomplishing this they have found insulation to be one of their principal aids in barring out cold in winter and heat in summer.

When all architects, builders, and home owners realize the importance of insulation in construction, the noninsulated home will be on a par with one that lacks plumbing or is lighted by candles.

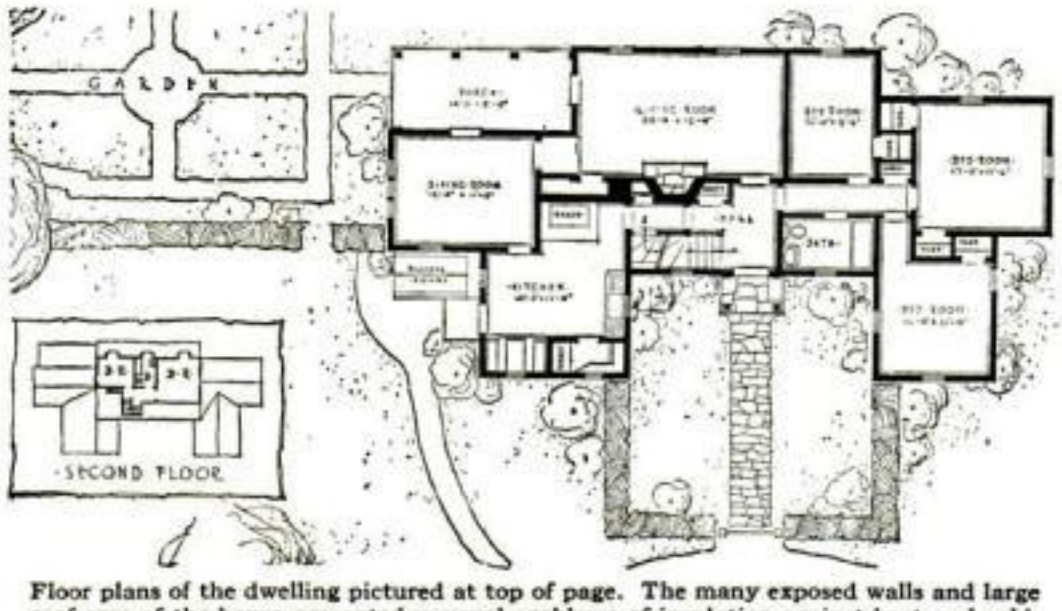
A striking example of how insulation may be used to add comfort in summer and winter is afforded by a cottage I saw recently at Riverside, Connecticut. Designed by F. Nelson Breed, a New York architect, this rambling story-and-a-half bungalow type home has a northwestern exposure swept by winter's bitterest gales.

The lot on which it is built borders Long Island Sound, has few trees to break the force of wintry gales or offer shade from the midsummer sun. But it is a delightful spot in summer and the owner knew that the house could be made comfortable for winter, no matter how severe the weather, if it were properly built.

In addition to the natural exposure of the site, the problem was made more difficult by the fact that the architect was asked to design a rather low, rambling house. This meant that there must be an unusual amount of exterior wall surface, with the living rooms, kitchen, and three bedrooms on the ground floor. Also it meant a large roof area for a comparatively small house, since it must spread over so much ground.

Both architect and owner realized it would be necessary to insulate the building if it was to be made comfortable in winter and if the cost of running the heating plant was to be kept within reason, but there was little money available for luxuries. The owner always had thought of insulation as a luxury, a kind of extra detail. Mr. Breed, however, pointed out that insulation would mean economy, particularly in this house because of its exposure.

The owner decided to get more information about the different insulating materials then used. He remembered that a friend had told him of having his new house insulated, but he also remembered that that new house was to have seventeen rooms and a four-car garage, and he felt that insulation was as much beyond



Floor plans of the dwelling pictured at top of page. The many exposed walls and large roof area of the house presented unusual problems of insulation against heat and cold.

his reach as a seventeen-room house.

A few days later, when he questioned his friend, it appeared that insulation had been an afterthought in the seventeen-room house, so that there was a chance for actual comparison of costs. That is, the house had been planned originally without insulation, just the usual stud wall construction, with sheathing, building paper, and siding on the outside, and lath and plaster on the inside; and construction prices had been obtained on this basis. Later, when insulating material was added, new prices were obtained and the difference showed that with insulation the cost was approximately two percent more than the first figures.

BUT for two winters the owner of the new house had checked his coal bills with those for another house about the same size—uninsulated. His bills each winter were less than those for the uninsulated house and so he figured that the difference represented his approximate annual saving. This saving would pay for the extra cost of his insulation in six years—leaving the insulation in the house as clear profit after that time.

But before this saving on fuel started another saving was made—much to the surprise of the owner. When the insulation was added to the walls the heating engineer who refigured the radiation and the heating plant explained that it is not so much the size of a room which determines the size and number of radiators as the amount of heat that would be lost through the doors, windows, and wall surfaces. He had figured on the size of the room, the walls exposed to the outer air, the size and position of windows and doors, and perhaps what is the most important factor—the type of wall *construction*. With these walls insulated the refiguring disclosed that the radiators in almost every room could be reduced a little in size. The total reduction made it possible to use a much smaller boiler than had been specified originally. The result was an immediate saving which offset a portion of the extra cost of insulation, without regard to the annual saving on fuel.

MR. BREED'S client was "sold" on the idea of using insulation in his cottage at Riverside, but the question now came as to what kind he would use and just where he should use it.

He found a variety of insulating materials of widely differing types available. With his architect he studied these products in an effort to determine for himself where they differed one from the other.

The first considered was insulating material held between sheets of tough paper and quilted in place. Next there was the loose form in which wool or fiber is placed as a packing between the studs or rafters. And then there were boards with the insulating material compressed into products which can be used more or less like sheets of lumber.

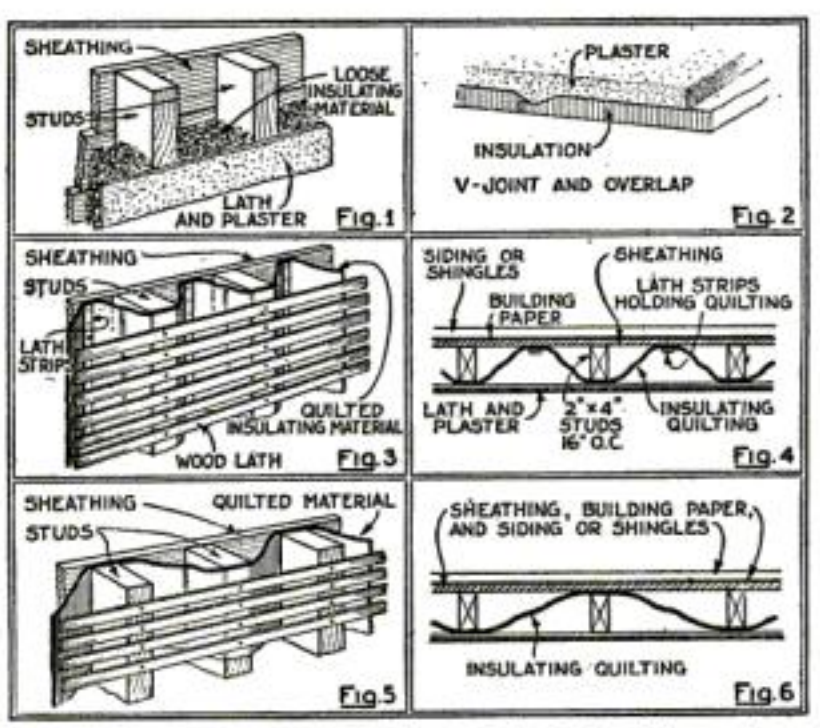
It was found that the raw material used in these different products is usually hairfelt, mineral wool, felt, or some kind of vegetable fiber. Within each is a tremendous number of small particles inclosing small—and, in some cases, minute—air spaces. This is in accordance with the well-known principle that air is the best nonconductor of heat, provided it is "dead" air—air so confined that it can not easily circulate.

Tests by the United States Bureau of Standards, by universities, and by private laboratories show that these various commercial insulating products are much alike in their heat-resisting value. Any one of them is about equal, in resisting the passage of heat, to an eight-inch brick wall or a 1½-inch pine board.

This attractive front entrance bespeaks the comfort assured within through use of insulating materials.

The owner of the Riverside cottage encountered a man who had insulated an old house with the loose material. At a nominal cost it had been stuffed into the walls without much tearing up of the old work. While not all the spaces in the walls were filled, it had been sufficient to reduce his coal bills appreciably. In the case of the new house this kind of material could be put between the studs as the sheathing was being applied, as shown in Fig. 1 on this page, giving an even filling throughout the exterior walls. There would always be the possibility that it might settle and pack down as time went on, leaving certain unprotected spots, but the manufacturers maintained that the roughness of the wood construction would hold it in place satisfactorily.

If the quilting, which stands well in the lists of efficiency, were to be used, there would be various ways of applying it. It could be put between the studs, against the inside of the sheathing, and nailed in the corners against the studs, or it could be used in the more usual way, over the inside of the studs, with the lathing nailed over it ready for plastering. Or it could be run zig-zag the way many builders and architects recommend; that is, starting on the face of a stud it would run to the sheathing midway between two studs, be fastened there with a lath strip, and then run back to the face of the next stud. A variation that uses a little less material is to nail it to the inside face of one stud and then to the outside face of the next and back to the inside again. The theory is that this zig-zagging breaks up the air spaces more and adds to the efficiency as insulation. The various methods are shown in Figs. 3, 4, 5, and 6 on this page.



These diagrams illustrate half a dozen methods of applying various roof and wall insulating materials to assure adequate protection.

But the advantages of using one of the boardlike materials seemed to Mr. Breed's client to outweigh in his case the slight differences in efficiency which the other kinds offered. In the first place, because of the rigidity and strength of these boards, they can be used in place of wood boards on the outside of the studs, eliminating both the sheathing and the building paper which are generally used. In this way insulating board is simply substituted for the sheathing and, though the cost is increased, real insulation is obtained. Of course, the increased cost is reduced somewhat by the saving in sheathing and building paper.

Another way of insulating with the boards is to apply them to the inside of the studs, where the lathing would ordinarily be put. While laths could then still be put on top of this it would be an unnecessary expense, as the plaster can be applied directly to the boards. Most insulating boards have such a surface that the plaster adheres to it perfectly and forms an unusually strong bond.

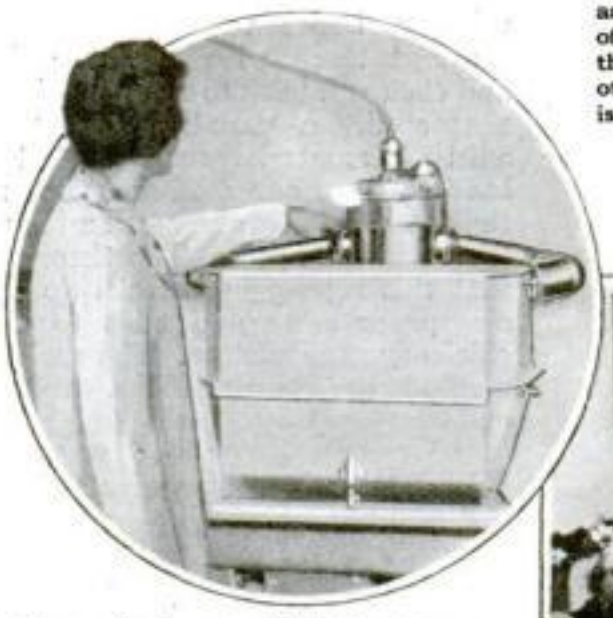
WITH some makes of insulating boards even the plastering may be dispensed with and wall paper applied directly to the surface of the boards. When this is done the joints between the boards must be carefully filled with a cement paste—usually supplied by the manufacturers—and then rubbed smooth to keep from showing through the paper.

An important improvement for using these insulating boards on the inside and as a "base" for plastering has been developed recently. They may now be obtained in comparatively small pieces, about eighteen inches wide and four feet long, instead of (*Continued on page 172*)

The New Household Inventions

Rugs can't slide or pull under vacuum cleaners when the latest antiskid buttons anchor them in place. Half of a fastener is attached to the floor at each corner. The other half, sewed to the rug, is quickly snapped into it.

A timing mechanism won't let you burn bread in this new electric toaster. When the toast is just right the current snaps off and the two doors open to deliver two golden-brown slices.



Clamped to faucets with Y-shaped arms, this new washer cleans your dishes with water swirled around by an electric pump.

By placing the washer on a rolling stand you can wheel your dishes to and fro.

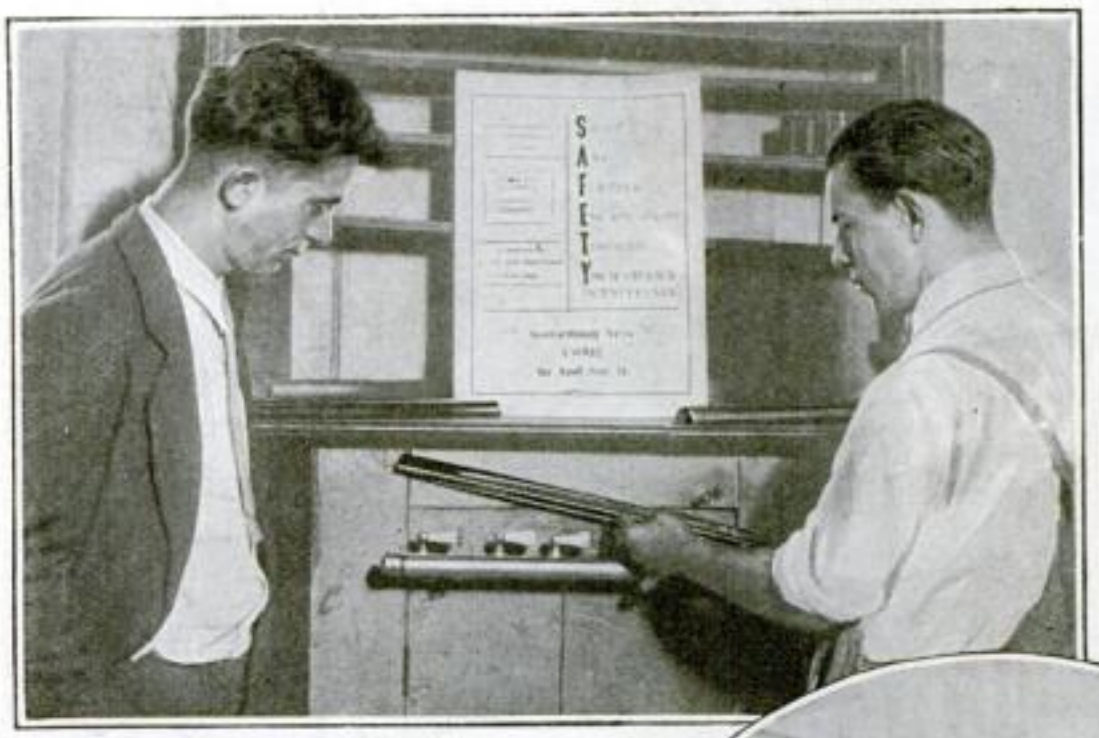
With this combined ice pick and bottle opener you can crack ice or uncork a bottle in a jiffy, thus saving time.

You'll shed no tears when you chop or slice onions with this glass-inclosed plunger. Put the vegetable on a wooden base, cover it, give the protruding handle a few strokes, and presto! the job is done "without a tear in an onion."

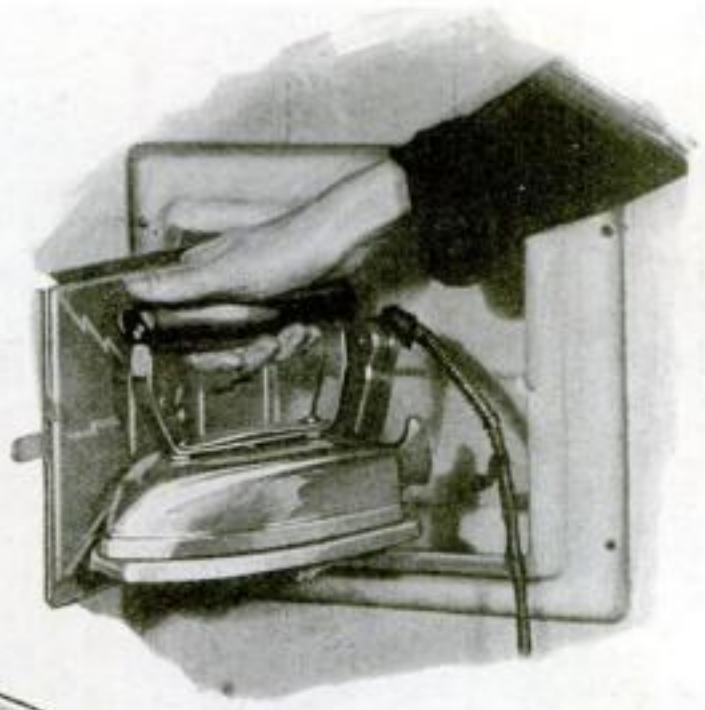
In addition to breaking up food particles to pass down the drain pipe, the washer's electric motor will run a cream-whipper, an egg-beater, or a small drill used on household jobs. A rotating brush also will remove cooked food adhering to pots and pans. To cleanse dishes add washing powder and a strong hot spray does the rest.

Here's a new improvement on an old household tool! An adjustable blade, held tight by a set screw, may be easily moved from place to place on this can opener to help you in cutting the covers of any tin containers.

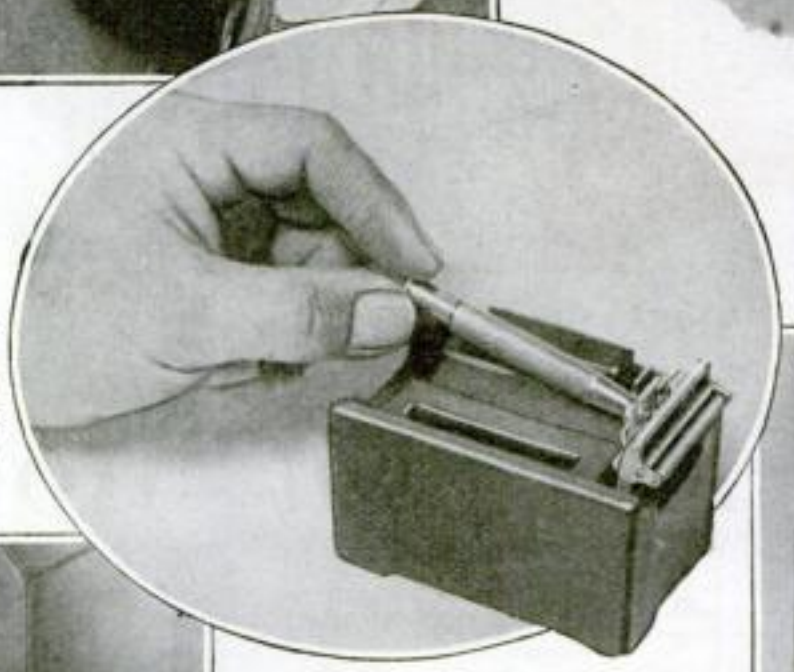
Mechanical Novelties in Wide Variety Offer Greater Convenience and Economy in the Home



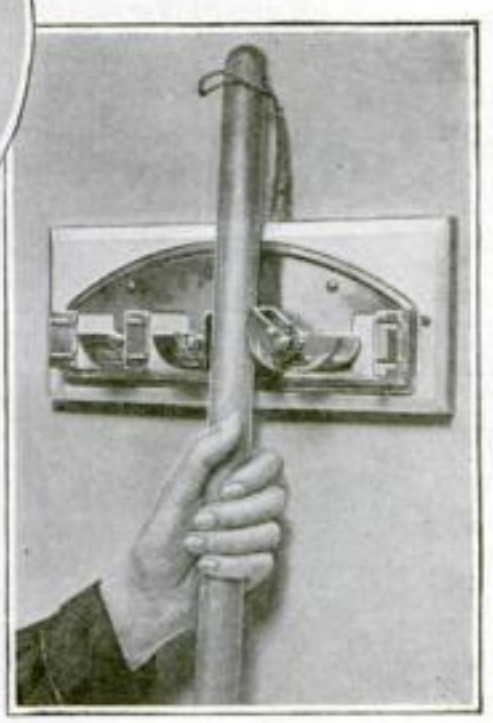
Insurance against accidentally opening the cocks of a gas range is provided by the simple lock-tight metal strip which P. Albanese, of Passaic, N. J., the inventor, is exhibiting. His device can be used on gas stoves with any number of burners.



Protected from dust and rust, your electric iron is tucked away in this built-in wall closet, which also serves as a rest for the iron when in use. Asbestos lining and a ventilated door allow safe storage of iron while hot.

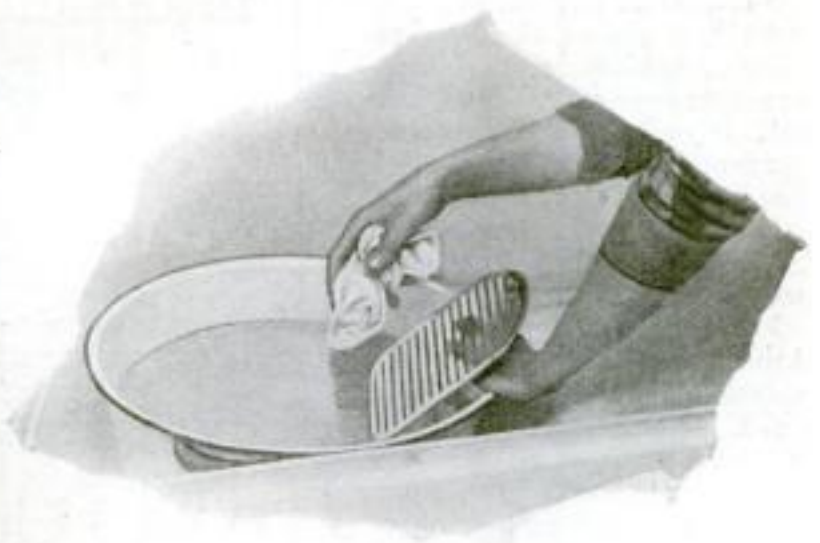


Your safety razor will never be out of place if it is kept on this convenient little china stand, which has a compartment for new blades and a receptacle into which the discarded ones may be dropped.



Brooms, mops, and household tools with handles can be conveniently kept in wall brackets like the one at the right. Curved nonskid holders grip the handles by spring tension as they are pushed into place. A lift removes the article when needed.

Here's a genuine "cooking cabinet" for summer as well as winter use. Inch-thick insulation prevents its heat from warming the kitchen. When its cover is shut a small simmer burner will keep food warm for hours. An "elevator" saves stooping to lift a roast, as shown above. Cooking odors escape up the chimney and the stove cannot be closed until every gas cock is shut. When closed, as at right, the cabinet resembles a parcel-post box.



For girls who prefer to launder their own fragile silk stockings and flimsy lingerie this little metal washboard is just the thing. Its curved handle fits the back of the hand that grips it, when placed in a basin, and its corrugations are declared to be harmless to delicate fabrics.

Smart furniture that is easy to build. This article tells you just how.

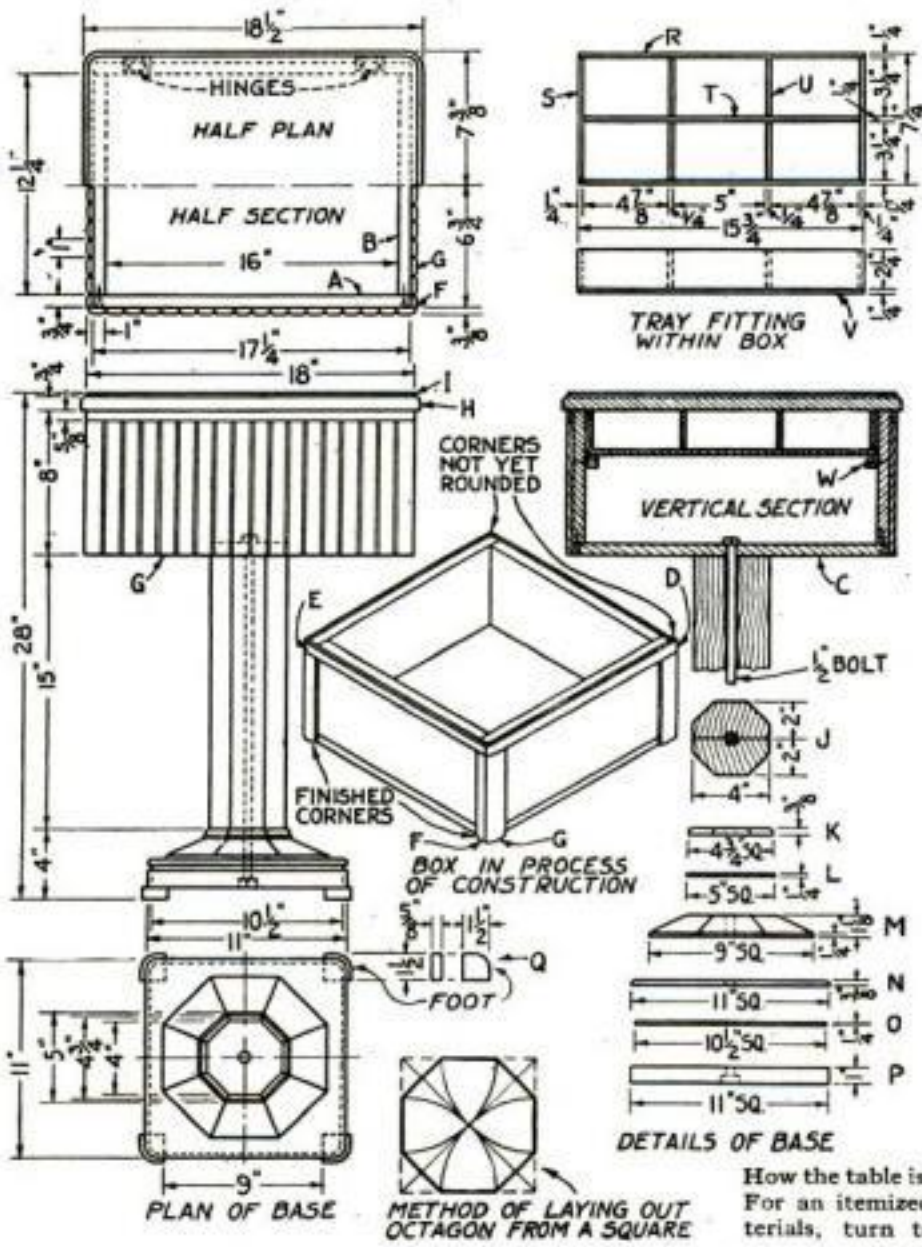
Sewing Table *in* Modern Style

By
H. J. ROSKYL

WITH the exception of dressing tables, most small, individual pieces of modernistic furniture seem to have been designed mainly for masculine use and enjoyment. In the accompanying illustrations, however, is shown a piece of furniture in the modern taste designed exclusively for the use of the lady of the house.

At first glance this sewing table or cabinet may seem to be rather complicated, but it is not. If each part of the table is examined, it will be found that the construction has been simplified in such a manner as to require only the simpler tool processes.

When the table is to be stained in a dark color and varnished or lacquered, gumwood, which is inexpensive and has a beautiful grain, is an excellent wood to use, unless the more costly walnut or mahogany is preferred. If the piece is to be finished with colored brushing lacquer or enamel, whitewood or some other close-grained, easily-worked wood will serve.



How the table is constructed. For an itemized list of materials, turn to page 119.

In constructing the upper or boxlike section, the procedure is to make an open box and screw the sides and bottom securely together. Next, four narrow cleats are glued to the outside of this box, flush with its upper edges. Brads, which are not driven all the way in, can be used to hold them in place until the glue sets; then the brads may be withdrawn.

The slats that transform this plain box into a cabinet of distinction are prepared and applied in the following manner:

Eight strips ⅜ in. thick, four of which are ¾ in. wide and four 1 in. wide, are cut to length in a miter box. Their edges are chamfered slightly. These slats are glued in place at the corners as shown in the isometric sketch. When the glue has dried, these corners, including the horizontal cleats, are planed round, after which the remaining slats, which are ⅜ in. thick and 1 in. wide, are glued in place.

The column is made of two pieces in which a groove for the bolt must be cut before gluing. It would be better for the amateur of limited

(*Continued on page 119*)

Who Can Match This Shop?

A. J. Stuhler, Who Likes to Make Things at Home, Pursues His Hobby with an Assortment of 1,238 Individual Tools and Machines

THAT kind of home workshop most of us have pictured only in our daydreaming A. J. Stuhler, of Monticello, Iowa, actually owns. Contained in two rooms, the shop includes 1,238 individual tools and machines. Each machine has an individual motor, and there are fourteen ¼-H.P., one ⅓-H.P., and one ½-H.P. motors.

The man who has assembled, set up, and even built part of this extraordinary assortment of tools and machinery is a member of a firm engaged in general merchandising and is himself occupied in managing the company's grocery store.

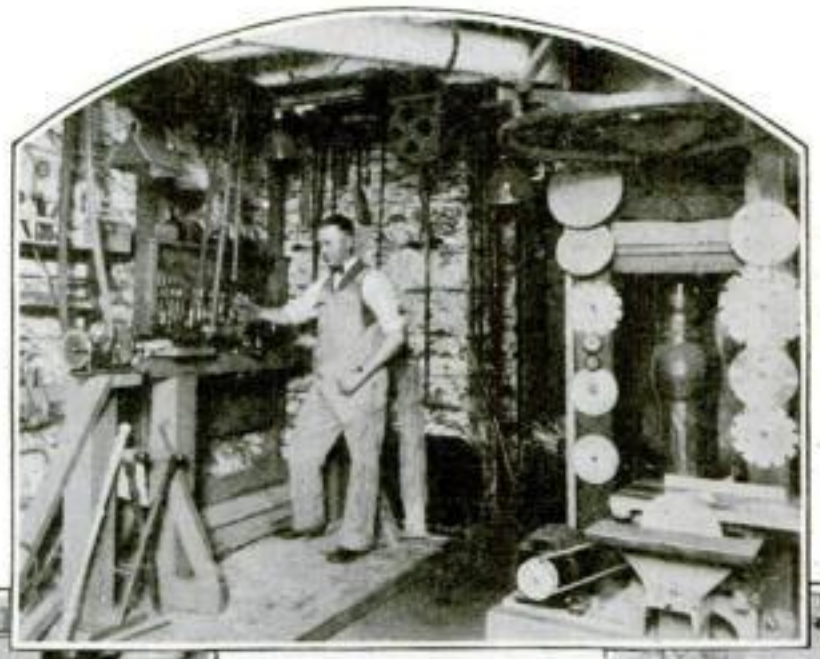


Fig. 1. Mr. Stuhler, who owns one of the most complete home workshops in the world, working at one of his lathes. Note the combination woodworking machine.

Fig. 2. Bench with electrical and chemical equipment, torches, and air brushes.

In Fig. 1 Mr. Stuhler is seen working at one of his lathes. He has an inclosed tool cabinet within easy reach, and at his left is a double emery wheel stand. At the extreme right of the illustration is a motorized woodworking machine consisting of a circular saw, planer, sander, buffer, grinder, and drill.

Flood and spot lights aid in doing close work, and a traveling flood light on an overhead cable can be adjusted to disperse any shadows.

Hardware supplies, an electrical kit for experiments, and a homemade test board supplied with D.C. and A.C. current are shown in Fig. 2. Here Mr. Stuhler also keeps his acetylene lead-burning and oxyacetylene torches, which are supplied from a tank on a ledge above the bench and with air from a homemade compressor, a part of which is visible at the extreme left. A cabinet at the right

Fig. 3. General workbench with conveniently arranged tools and machines.

end of the bench contains a fairly complete miniature chemical laboratory for experimental work and for use in conjunction with an electroplating outfit. Under the bench are several air brushes for spraying lacquer, and on a turntable at the extreme right is a motor-driven sprayer. The upper part of the cabinet at the right contains a complete set of alcohol and gasoline *(Continued on page 128)*

PERHAPS your own home workshop, while it may not be nearly as large or complete as the shop of Mr. Stuhler, has in it some outstanding features of equipment or arrangement which would interest the readers of POPULAR SCIENCE MONTHLY. If so, send photographs of it with a brief description to the Home Workshop Editor. Payment will be made for all photographs and suggestions that are considered suitable for publication.

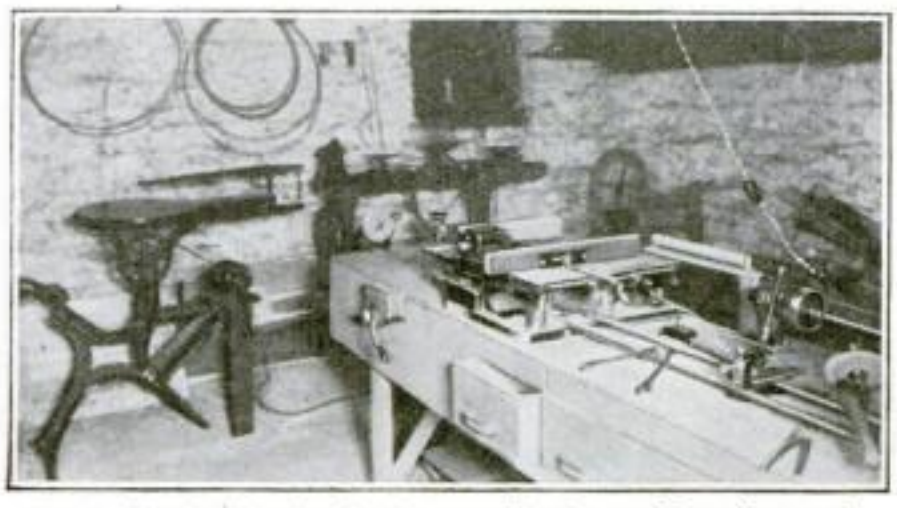


Fig. 4. Woodworking bench with a combination machine and a wood-turning lathe. In the background is a heavy jig saw and a speed lathe.

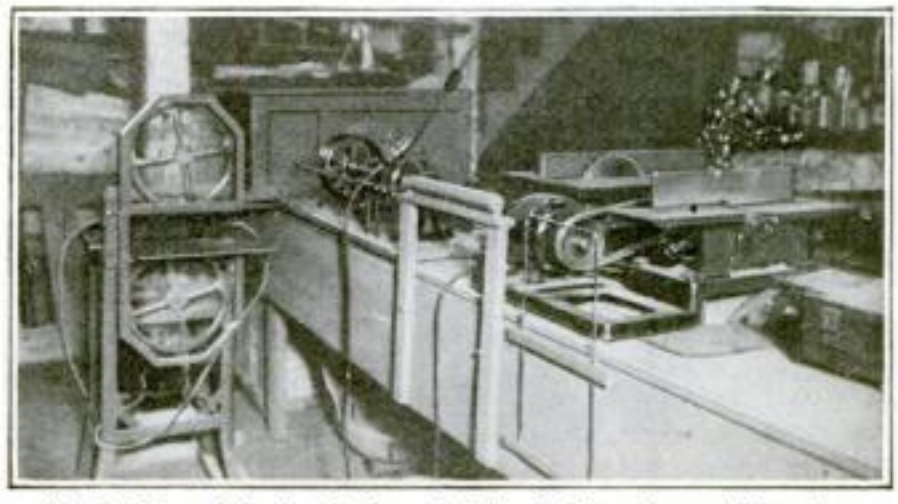


Fig. 5. Rear of the bench shown in Fig. 4. Note the small band saw. In this room, but not shown, are also a shaper for wood and a jointer.

Turning Fancy Boxes *and* Bowls

By HERMAN HJORTH

Attractive wooden fruit dishes and nut bowls can be made easily by the amateur turner.

MAKING small boxes is one of the most interesting and fascinating types of work that can be done on a wood-turning lathe, for the possibilities in the choice of size and design are almost without limit.

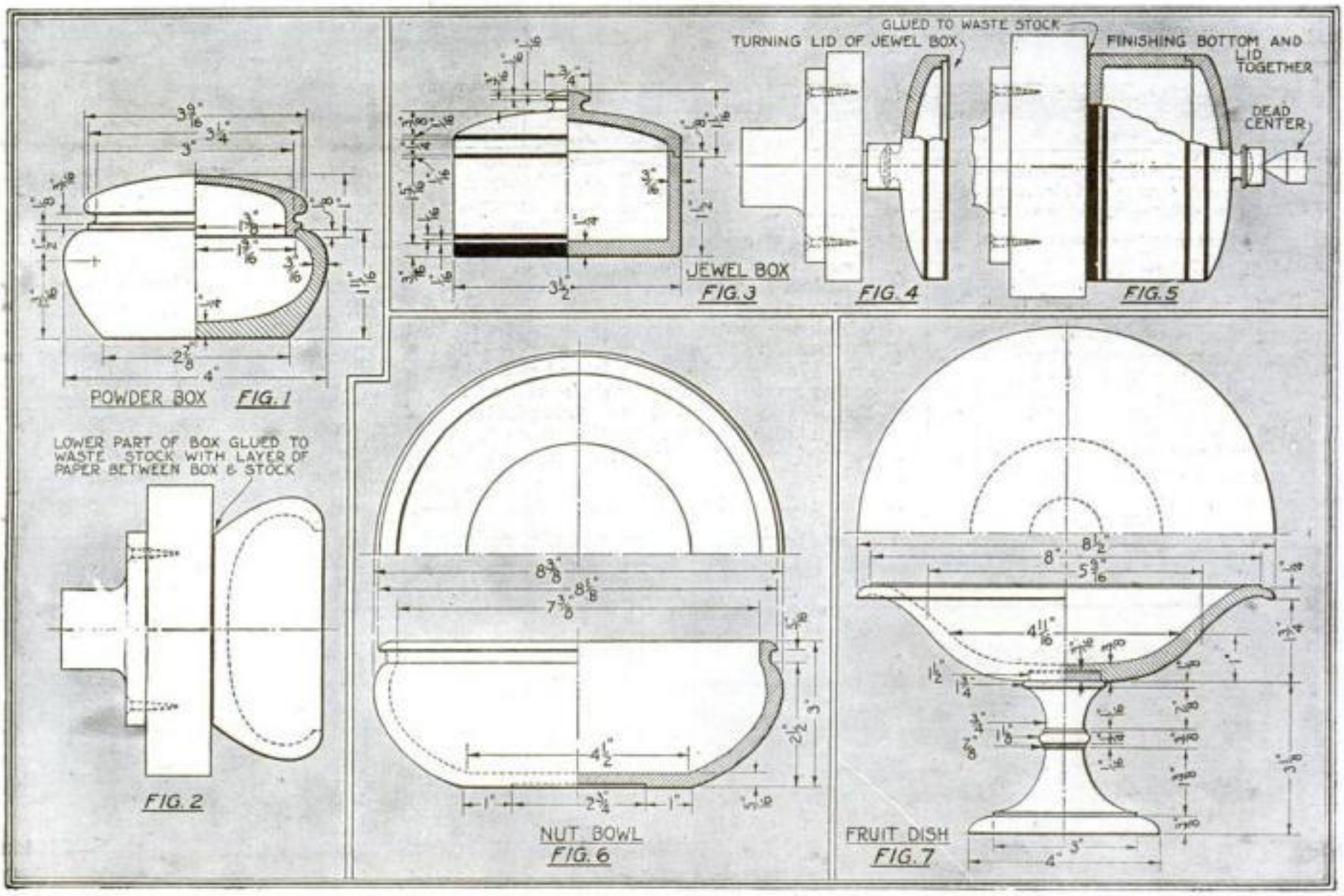
The cover of the powder box, Fig. 1, is turned from a piece of wood at least 1 in. more in diameter than the finished dimensions call for. This piece of wood is securely screwed to a faceplate or screw chuck, after which it is turned to diameter and leveled. It is best to turn the inside of the cover first, and then to cut the recess which fits into the lower part of the box. Use a template for this work. When the outside of the cover has been turned, it is cut off with a parting tool or skew chisel as near to the line as possible. Hold the parting tool with the right hand and grasp the lid with the left hand the moment it is cut away from the waste.

The lower part of the box is turned in the same manner as one of the trays illustrated in last month's article (Fig. 4, page 81). It is cut to approximate size, glued to waste stock (Fig. 2), and turned in the usual manner.

Particular care must be taken to turn the diameter of the opening so that the cover will fit snugly and yet not so tightly that it must be forced in place. The size of the opening should be tried while it is being turned by fitting the cover to it.

The lower part of the box may be used as a chuck for the lid, which must be smoothed off and sanded at the central point where it was cut with the parting tool. The whole box is now stained and polished, after which its lower part is removed from the waste stock by driving a sharp chisel into the latter 1/16 in. behind the glued joint. A recess may be cut on the underside of the box by chucking it in the manner shown in Fig. 7 of the article published in the March issue.

The jewel box, Fig. 3, is turned in exactly the same manner as the powder box; but as it is inlaid, the stock must be prepared in a different way. The lines of inlay are produced by gluing different colored woods together in layers. The lowest layer, for example, may be a dark-colored piece of wood, such as black walnut or imitation ebony, 3/16 in. in thickness. The next layer is a light-colored wood, such as maple or birch, 1/16 in. thick. This is followed by a dark layer 1/16 in. in thickness, and this again by (Continued on page 117)



Four designs especially prepared for readers of POPULAR SCIENCE MONTHLY. The proportions and contours have been given careful study and in many subtle ways differ from ordinary turnings. It will pay the beginner to copy one or more of these before attempting to make designs of his own.

Hammering Out Metal Trays

You Will Be Surprised How Easy It Is to Make and Emboss Artistic Looking Receptacles for Ashes, Cards, or Pens

By EDWARD THATCHER

Fig. 1. How a rectangular tray is formed in the vise with the aid of a homemade tool.

SMALL card, ash, and pen trays (Fig. 2) are easy for the beginner in decorative metal working to make. They form useful and acceptable gifts and, when well shaped and neatly finished, can be sold at a profit if a local market can be found for them.

Round trays in the smaller sizes are usually hammered from copper or brass, gage No. 20 or 22. In this process turned wooden molds are used as shown in Fig. 3. Naturally, a separate mold must be prepared for each size.

A disk of well-annealed metal is centered over the depression in the mold and small nails are driven part way into the wood and bent slightly inward to hold the edge down as shown in Figs. 3 and 4. The metal is driven into the depression by hammering around and around in one line just inside the edge with the rounded end of an embossing hammer. The hammering, which must be done only at the edge of the depression, stretches the metal until it reaches the bottom of the bowl.

To aid in centering the disks, several concentric lines are turned in the top of each mold. It is easy to make a number of trays exactly alike, but do not attempt to make trays more than 8 or 10 in. in diameter or of thick metal. Beech or maple is an excellent wood for the molds; it should be from 1½ to 2 in. thick.

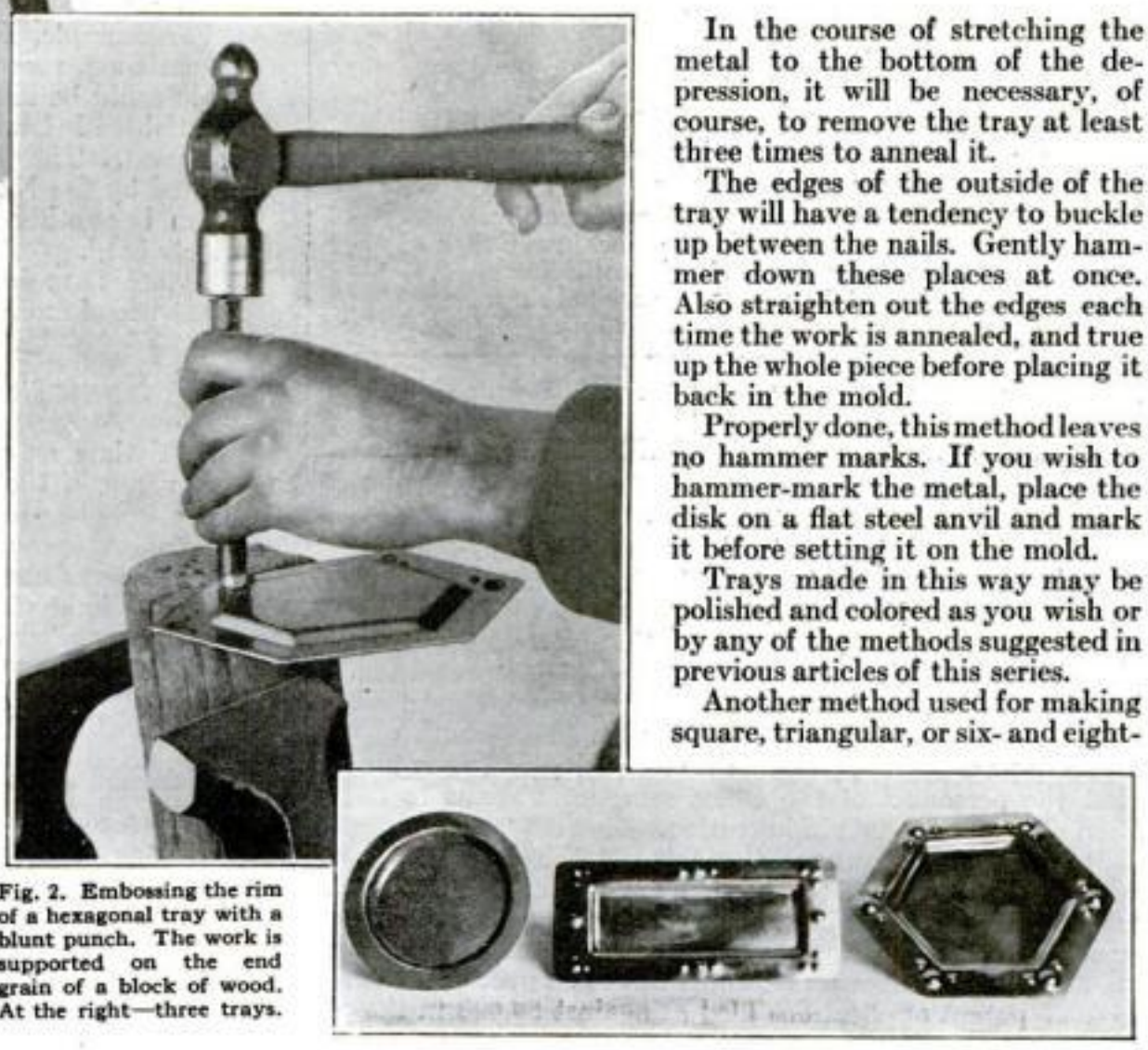


Fig. 2. Embossing the rim of a hexagonal tray with a blunt punch. The work is supported on the end grain of a block of wood. At the right—three trays.

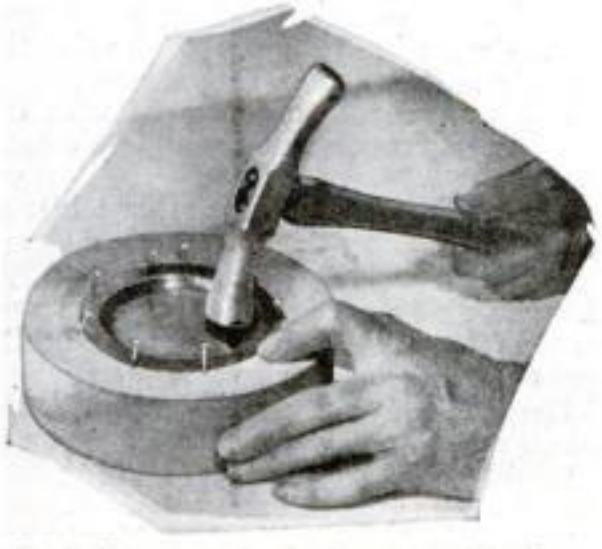


Fig. 3. Using an embossing hammer to drive the sheet copper into a turned mold of hardwood.

To prepare a disk of metal for a tray, scribe a circle of the proper diameter and first cut a square containing the circle. Cut off the corners of the square close to the circle and then trim away the remaining metal, making a continuous cut with the shears. Never try to cut out a circular piece directly from a large piece of metal.

THE metal is annealed by heating it to a dull red and quenching it in a "pickle" made of ten parts water and one part of either nitric, sulphuric, or muriatic acid. In making the pickle, add the acid *slowly* to the water. *Never pour water into acid;* it is highly dangerous. Rinse the work in clean water and allow it to dry. To fasten the disk over the mold, use at least eight small nails.

For the actual hammering you cannot use a common ball peen hammer; you must either buy or make one or have a blacksmith forge one for you (see the article *Tools for Metal Working*, June, 1928, issue, page 104).

In the course of stretching the metal to the bottom of the depression, it will be necessary, of course, to remove the tray at least three times to anneal it.

The edges of the outside of the tray will have a tendency to buckle up between the nails. Gently hammer down these places at once. Also straighten out the edges each time the work is annealed, and true up the whole piece before placing it back in the mold.

Properly done, this method leaves no hammer marks. If you wish to hammer-mark the metal, place the disk on a flat steel anvil and mark it before setting it on the mold.

Trays made in this way may be polished and colored as you wish or by any of the methods suggested in previous articles of this series.

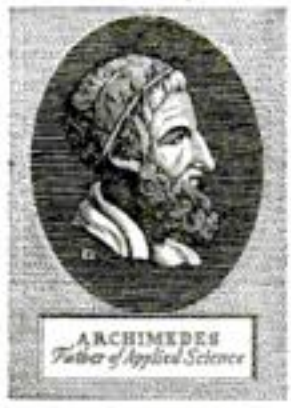
Another method used for making square, triangular, or six- and eight-sided trays is illustrated in Fig. 1. The vise jaws are protected with false jaws. These are made of sheet copper about 2 in. wide and as long as the vise jaws. They protect the trays from being scored by the jaws.

A wooden tool made as shown in Fig. 5 is used to drive down the metal as indicated. The tool may be made from a length of broom handle or a large maple dowel stick.

Copper or brass of gage No. 20 should be used. For a rectangular tray, cut the metal slightly larger than the finished size, because the outer ends will be drawn in slightly. Enough metal should be left to allow the edges to be squared up later. After annealing and pickling the metal, draw the inner rectangle with a pencil, not a scriber.

With the pencil line even with the top of the vise jaws, clamp the metal as tightly as possible. Drive the wooden tool gently along the top of the jaws, making at first merely a slight depression. If the tray is longer than the vise jaws, loosen up the work and reclamp it as you work along. Do all four sides in the same way, trying (Continued on page 126)

Popular Science MONTHLY



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Protecting Yankee Ingenuity

B. T. STEBER, of Utica, N. Y., in a letter to POPULAR SCIENCE MONTHLY, criticizes the conduct of the U. S. Patent Office. He charges that instead of serving as an incentive to invention, for which it was intended, the Patent Office stifles initiative by dilatory methods.

Complaints of this kind are frequent. The length of time taken to pass upon application is often criticized, as is the fact that the personnel of the Office sometimes seems to fail to keep abreast of trends in invention.

It is only fair, however, to point out the difficulties under which the Patent Office labors. Inventions revolutionizing whole industries have been following one another in swift succession. Each, in turn, breeds hundreds of other inventions. Radio and aviation are cases in point. The year 1927–28 saw 117,000 patent applications filed as against 86,028 in the previous year.

Nevertheless, improvement is urgently needed. We are the most inventive nation in the world. The whole structure of our present prosperity is built on what used to be called "Yankee ingenuity." It is difficult to name an industry that is not expanding as a result of the applications of inventive science.

Readers who have suffered from delays of which Mr. Steber complains are urged to tell us of their experiences to the end that we may lay them before the proper authorities.

Keeping a Step Ahead

MR. McMAHON'S story of Wilbur and Orville Wright, now appearing in POPULAR SCIENCE MONTHLY, lays stress on the skepticism with which the airplane was received. In this connection it is interesting to recall that this magazine was the first to give credence to its invention. Our issue published in December, 1903, a few days before the first successful flight, said editorially: "The flying machine is no longer problematical; it is simply a question of the time necessary to put things together."

That sentence was written at a time the Wrights were facing ridicule. And in our issue for March of 1904, Octave Chanute, whose part in the development of the airplane Mr. McMahon so graphically portrays, wrote describing the first flight in detail.

For more than half a century, writers for POPULAR SCIENCE MONTHLY, unswayed by popular misconceptions, have been keeping up with, and just a bit ahead of, the march of progress. Every significant invention and discovery has been scrutinized, analyzed, and evaluated in simple language for our readers.

Today, as in the past, these men do more than report known facts. Month after month, on the basis of their knowledge, they look into the future and make remarkably accurate prophecies of the wonders to come.

Wherever men are doing new and useful things, there you will find writers for POPULAR SCIENCE MONTHLY.

Why Not Make Use of Them?

IT SEEMS only the other day that Jack Binns, from the *Republic*, first used radio to send a distress call from a sinking vessel. In this issue is told the story of the use of another scientific development in saving life at sea—the radio compass. We marvel as we read the story of the rescue of the crew of the *Florida*. Yet few of us stop to realize that after all we make comparatively only meager use of the available gifts of science at sea.

For example, Robert H. Marriott, of the Federal Radio Commission, recently pointed out that although an electrical cable could be laid in New York Harbor that would allow a blindfolded helmsman to follow the channel, such a device is not used. The practicability of the idea has been demonstrated by the Navy. Using an echo to tell the depth of the ocean is another navigational method that should be more widely used.

Aviators are demonstrating what can be done by the intelligent use of modern navigational methods.

Something More to Worry About

ANY time an otherwise obscure scientist desires to get his name in the papers he does a bit of calamity howling. Sometimes he predicts a famine in oil or coal or wood, but the most popular prediction is that the world is coming to an end at some not distant date.

In the light of recent scientific revelations, these calamity howlers are pikers. It now is possible to predict, if you want to, instantaneous annihilation—the end of everything for all of us!

Light travels at an approximate speed of 186,000 miles a second. Recently, the astronomical observatory at Mount Wilson, Calif., observed a whole collection of stars in the form of a nebula traveling away from this earth at a speed of 2,500 miles a second. No scientific evidence is available to show that this or any higher speed is the ultimate limit.

Assume for the moment that there are other stars, gigantic stars, traveling at even higher speeds, perhaps as fast as light itself, and traveling toward the earth instead of away from it. We couldn't see the light from them until the stars themselves reached the earth. In other words, unseen by us, a blazing sun as large as our own may, at this very minute, be rushing at us out of the depths of space at a speed equal to or greater than that of light.

So if you enjoy worrying about things, you ought to be able to get a real kick out of that gloomy prospect! But really there is no more scientific evidence to support such a theory than there is to support many of the possibilities pessimists like to point to.

They Are Saying—

"TALL buildings are a menace to health."—Shirley W. Wynne, New York City Health Commissioner.

"Of ten possibilities of danger in aviation, eight involve the take-off."—Juan de la Cierva, inventor of the autogiro.

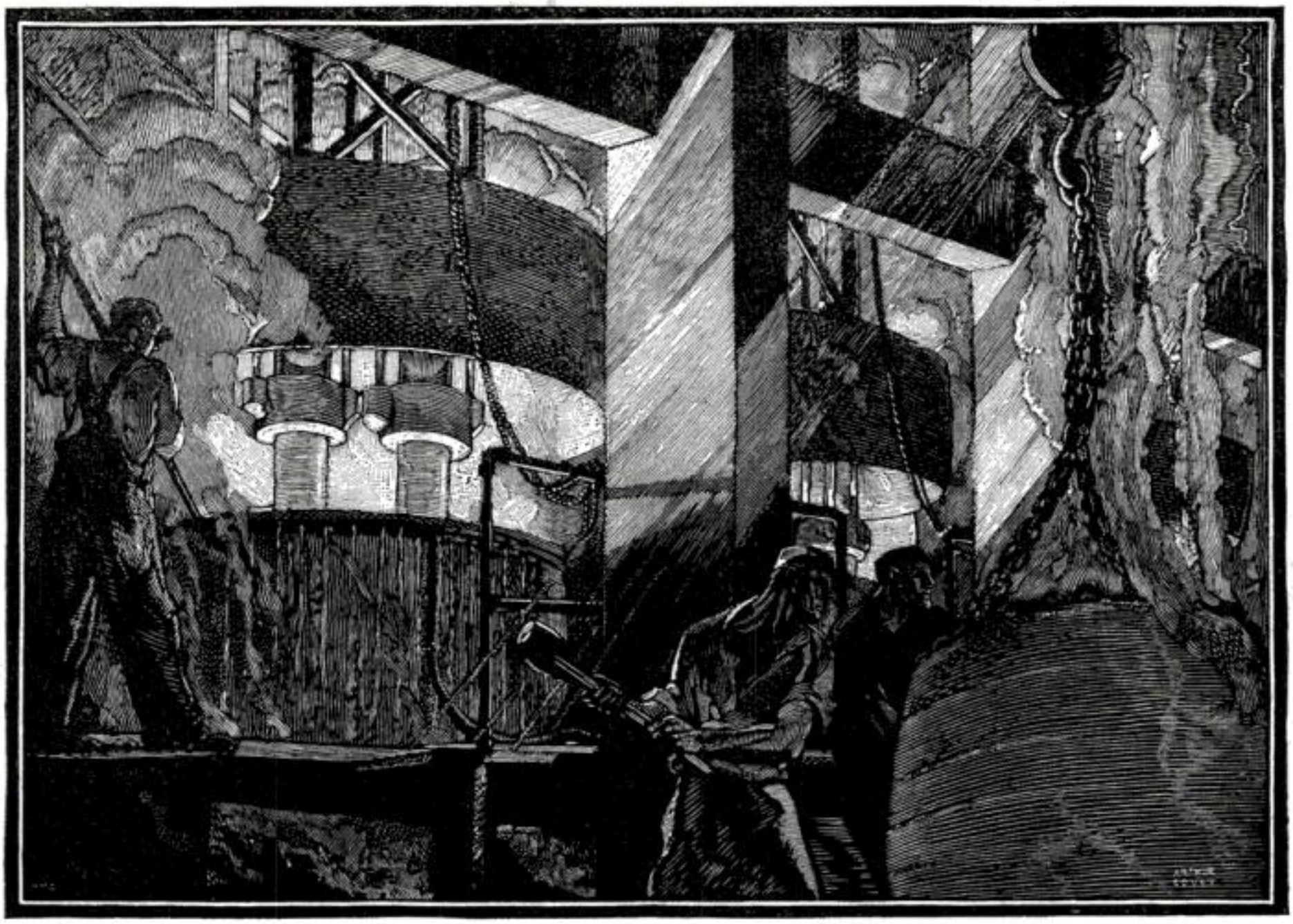
"What do my 300 burns amount to compared with the thousands of patients that my work has saved!"—Fernand Ducretet, French X-ray martyr.

"When you are successful in pitting brain against bits of iron, metals, and crystals and making them do what you want them to do, that is all the reward you want."—Prof. A. A. Michelson, famous American physicist.

"Man's two needs are a family doctor to safeguard his health and research to enlarge the doctor's knowledge."—Dr. Joseph C. Bloodgood, Johns Hopkins University Medical School.

"A kangaroo is just an abortive attempt of Nature to make a safe pedestrian."—Lord Dewar, English industrialist.

"An average pine tree manufactures a broomstick a day and uses two barrels of water to help do it."—Dr. D. T. Macdougal, Carnegie Institution biologist.



Mural by Arthur Covey. Wood block engraving by Howard McCormick

HEAT and the bright light of the electric arc! Smoking cauldron and smoking pig! The attendance of careful men; the sledge blows of men of brawn. All these caught by the master's brush and preserved for posterity on the walls of Norton Hall at Worcester in Massachusetts.

All who view the scene may know how Bauxite clay from the mines of Arkansas, by energy taken from the waters of Niagara, is fused in the electric furnace and becomes the hard, tough material known in industry as the abrasive trade-marked "Alundum."

By day and by night, while we wake or sleep, these fiery furnaces burn on, continually bringing forth the abrasive which is to serve mankind in a multitude of ways.

From the abrasive, trade-marked "Alundum," are fabricated the grinding wheels employed in all-important machinery operations in metal-working plants and many others. By the aid of grinding wheels there are produced countless machines of production and of transportation, and by the grinding wheel they are brought to mechanical perfection.

For the great paper industry, manufactured pulpstones reduce logs at tremendous speed into fine, even-grained pulp.

For the broad and ever increasingly important field of chemistry, laboratory ware made of this abrasive, capable of withstanding terrific heat, performs an invaluable service.

For the architect and the builder Norton floors, non-slip and remarkably durable, supply a need in modern building construction. The basic material of Norton floors is this electric furnace abrasive.

For great cities employing the activated sludge sewage disposal systems and industries where filtering operations through plates are required this material serves in the form of Norton porous plates.

In the beginning, manufactured abrasives supplanted natural quarried stones for sharpening and snagging. Today their use has been extended through the agency of the grinding machine to a high place of importance in the machine age in which we live and many are the by-products which time has proved definitely valuable to the progress of the world.

NORTON COMPANY, WORCESTER, MASS.

NORTON

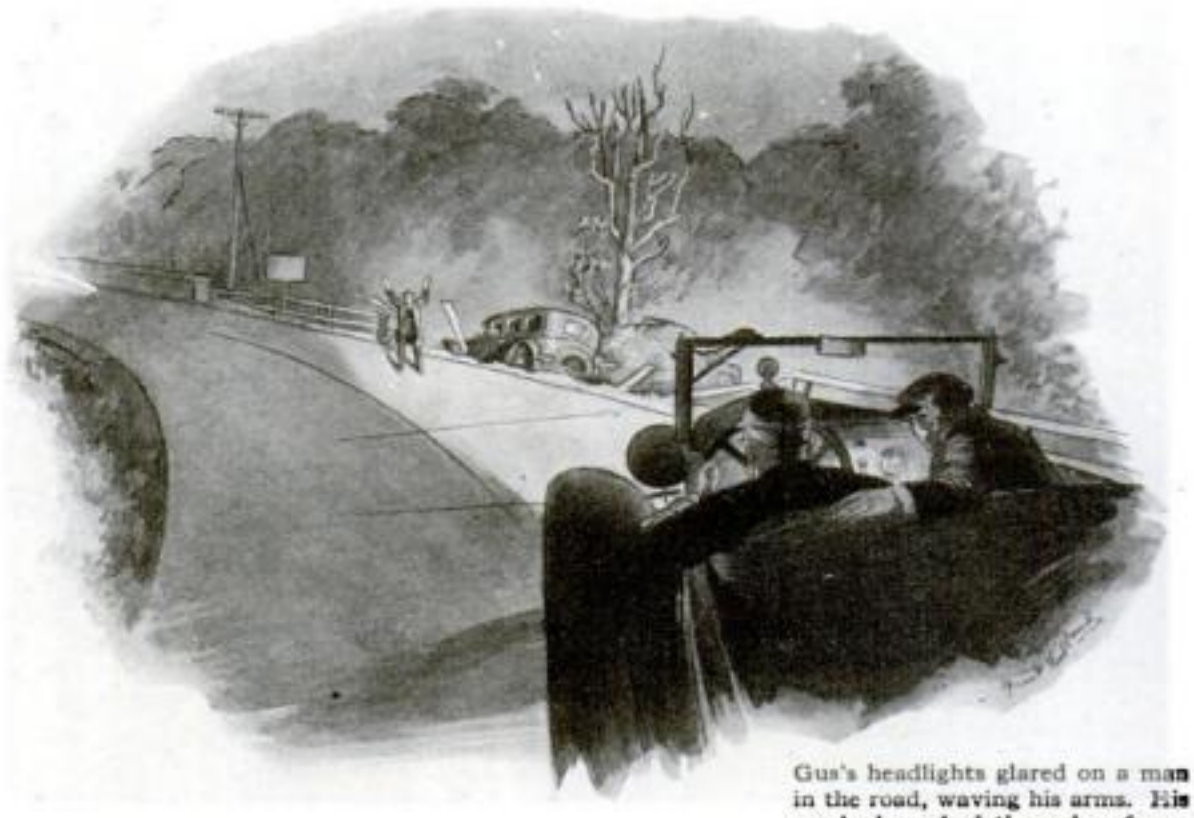
Grinding Wheels
Grinding Machines

Refractories-Floor
and Stair Tiles

If Your Headlights Went Out—

And You Were Speeding Forty Miles an Hour, What Would You Do? Gus Explains the First Rules for Safe Driving

By
MARTIN BUNN



Gus's headlights glared on a man in the road, waving his arms. His car had crashed through a fence.

"WE'D better step on it, Gus; the wife'll have the eats waiting by now," Joe Clark urged as he locked the door of the Model Garage and hastily climbed in beside his partner.

"Huh!" snorted Gus Wilson. "You don't have to tell a hungry old bachelor to hurry when there's home-cooked fodder in sight!"

The veteran auto mechanic snapped on his lights, for it had become quite dark, and swung out onto the concrete road. The gears whined in second while the car gathered headway and then, as Gus noiselessly shifted into high, a sedan whizzed past them at high speed.

"Another guy late at mealtime maybe," Gus suggested. "He sure is in one great big hurry."

The sedan rapidly drew away from Gus's car and the tail-light finally winked out as it reached a distant bend in the road.

"Something's funny or else I'm losing my sense of distance," muttered Gus. "How did he get around that bend so quick? Didn't seem to me he'd even reached it."

"G'wan!" Joe grinned. "Of course he did. Where else could the lights go?"

But when they reached the bend, Gus's headlights glared on a man standing in the road and waving his arms to attract their attention. The front end of the sedan was jammed through the fence on the outside of the pavement.

"What happened?" asked Gus as he pulled up.

"Lights went out all of a sudden," explained the stranded one. "I reached over to see if the switch had snapped off, and the next thing I knew I hit the fence."

GUS got out a flashlight and rapidly inspected the wiring. "Here's the trouble," he grunted. "Wire broke off right at the switch." He reconnected it and the lights came on at once. Luckily nothing vital appeared to be broken, so he backed the car onto the road again.

"Better bring it down to the Model Garage tomorrow and I'll make sure everything is all right and take the wrinkles out of that mudguard."

The accident victim muttered something unintelligible and immediately drove off.

"And not so much as a 'thank you,'" Joe whistled in astonishment.

"Don't blame him," Gus smiled. "He's just scared stiff. Kind of 'accident shocked.'"

Gus's suggestion had registered, however, for the next day the man appeared at the Model Garage.

"My name's Considine," he began, "and I want to thank you for what you did for me last night. That was my first accident and it sure did scare the daylights out of me. Spoiled my self-confidence, too. I'm nervous as a cat now."

"DON'T let it get your goat," Gus smiled as he started ironing the dents out of the mudguard. "It's no disgrace to be a beginner so long as you don't get to think you know it all. Trouble is, there's a lot to driving besides shifting gears and turning the wheel. And most people are lucky if they find that out before they get into a serious crash."

Considine smiled ruefully. "Yesterday I'd have said that was a lot of bunk. Now I know better. What would you have done if you'd been in my place last night?"

"That's easy," replied Gus. "My foot would have been pushing a hole in the floor board with the brake pedal the instant after the lights went out, and I'd have watched the sky line along the trees to keep me on the road till I stopped.

"But," added Gus, "if I'd been you I wouldn't have been driving so fast. You oughtn't to drive fast until you've had more road experience. Lots of things can happen when you are hitting it up that wouldn't mean anything if you were going slower. A blow-out, for instance, means nothing if you're ambling along, but it takes a good man to keep a car on the road if a tire lets go at high speed."

"How fast ought I to drive, then?" Considine inquired.

"Well," said Gus, "when I first tackled driving a gasoline buggy, back in the days when a progressive gear shift was the latest thing and cars didn't have any windshields, the man I was working for took me out for my first lesson. We were roaring along at thirty miles an hour—dangerous speed in those days—when all of a sudden the boss jammed on the brakes and I nearly dove over the hood, seeing as how there was no windshield to stop me. 'There,' said he, after I'd crawled back into the seat, 'I just wanted to show you the first principle of safe driving, and that is to know how to stop quick. Never drive so fast that you can't stop within the clear space you can see ahead.'

"THAT principle is just as good now as it ever was, and it's a kind of automatic rule, because while you're a beginner you won't be able to make as quick stops as you will after you get so that your foot snaps onto the brake pedal without having to stop and think about it. Whenever there was any doubt in my mind whether I was going too fast I used to imagine another car darting out of a side road and see how quick I could stop—but you want to be sure there's no car behind you when you try it!"

"I thought four-wheel brakes made fast driving safe," said Considine.

"Safer—not safe," Gus stated. "Nothing can make driving safe if you're going too fast. Of course, other things being equal, you can hit it up a bit more if you have four-wheel brakes.

"And while we're talking about speed," Gus continued, "remember that a safe speed on dry roads is a lot too fast when the going is (Continued on page 174)

Rarely is a house built with enough closets, but any man can make fittings to increase their capacity.

More Closet Space

How to Gain Room for Storing Clothes Simply by Adding Shelves, Coat Rails, Hooks, Hangers, and Various Fixtures

By L. M. ROEHL

YOU can put more of the closet space in your home to practical use by building in additional shelves, coat rails, and compartments and by adding hooks, rods, and hangers.

Figure 1 shows a simple and practical way to place shelves at the back or end of a closet. A post, ¾ by 1½ in. and of a length to reach from the top edge of the baseboard to the ceiling, is placed at each side of the closet as shown at *A*. Posts *B* of similar size, about 1 ft. long, are set in the corners at the back between the shelves, which may be as wide as desired and as long as the width of the closet. The shelves are held in place by nailing through the long post, as shown at *C*. This places the first shelf about 18 in. from the floor.

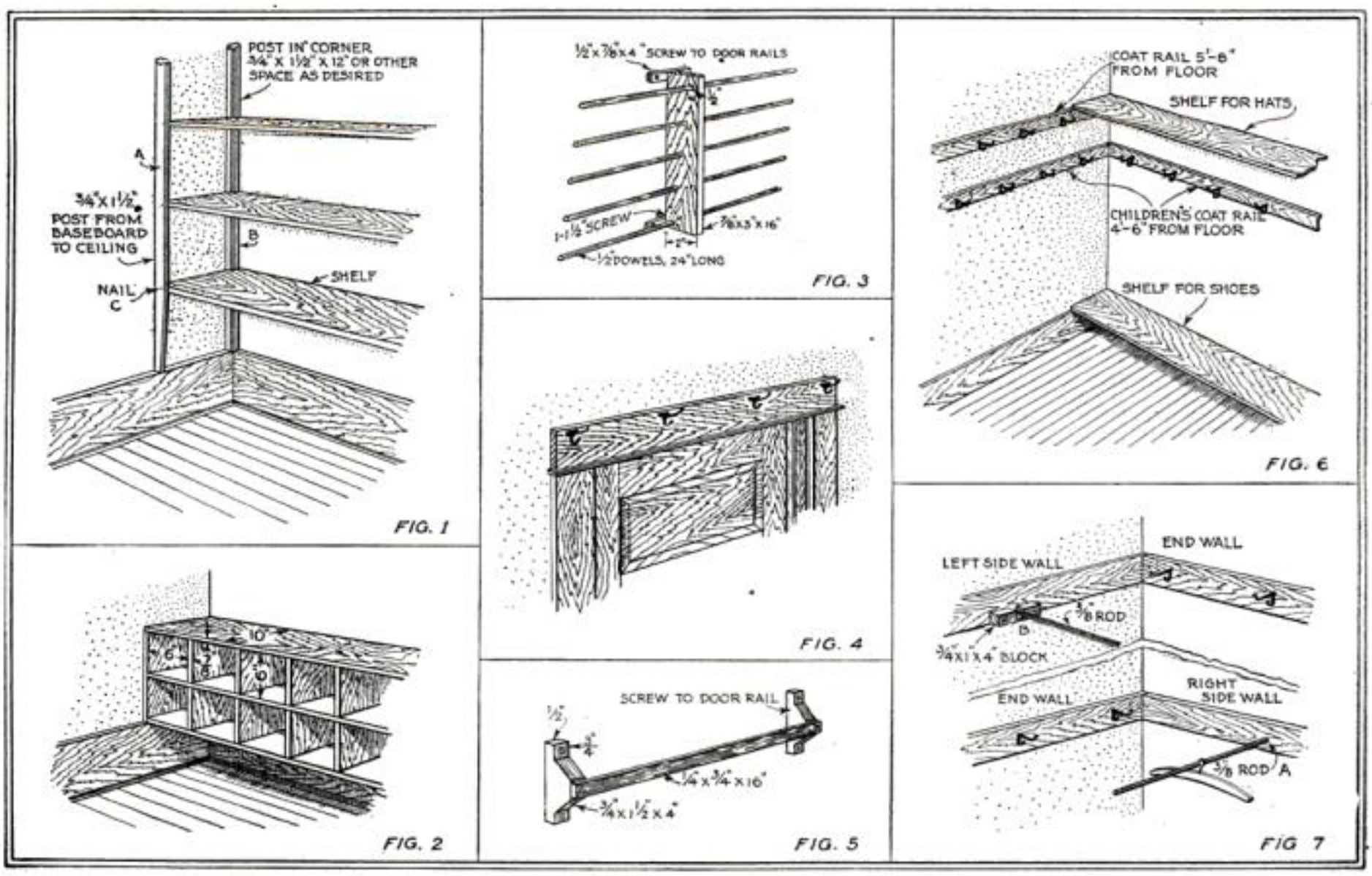
The front post may be toenailed to the wall, and the baseboard and the corner posts facenailed. By building the shelving to the ceiling, materials that are not frequently used may be stored on the upper shelves, and thus space is used that otherwise would be idle.

Another way to increase the working space in a closet is to build two coat or cloak rails as indicated in Fig. 6. In addition to the usual rail at 5 ft. 8 in. from the floor, an additional rail is placed at 4 ft. 6 in. from the floor. This is especially helpful for children's use. The hooks on the lower rail are placed halfway between those on the upper rail.

Figure 6 also shows a shelf placed on the top of the upper rail for hats and mittens; and resting on the baseboard is a shelf for shoes. The latter should be 11 or 12 in. wide. It is well to finish the shelf with spar varnish. It need not be nailed to the baseboard; thus it may be taken out for cleaning.

A method of keeping rubbers and mittens in a closet is indicated in Fig. 2. Three shelves are placed 6 in. apart, and on them partitions are placed so as to make compartments 6 in. square. The case is built or placed on the baseboard at the back or end of the closet. It should be noted that the shelves are 10 in. wide and that the grain of the wood in the partitions runs vertically. By this construction, pieces 6 in. long may be cut from a 10-in. board for the partitions; in like manner two pieces 13¾ in. long may be cut for the ends if the wood is ⅞ in. thick.

A simple and satisfactory way of hanging a rod for holding coat hangers for coats and dresses is illustrated in Fig. 7. A ⅜- or ½-in. iron or brass rod, or a ½-in. piece of hardwood doweling, is placed across the closet at about 18 in. from the rear end. One end of the rod is placed in a hole in the coat rail as shown at *A;* the other end is held (*Continued on page 125*)



Seven ways to increase the capacity and usefulness of the ordinary clothes closet with shelving, racks, and extra hooks. Mr. Roehl, who offers these suggestions, is an assistant professor in the Department of Rural Engineering, Cornell University, and is the author of "Household Carpentry."

Fix It Yourself with These

Handy Hints for Motorists

How to Keep Your Windshield Wiper Working, Build a Nest for Tools, Grind Valves an Easy Way, or Rig a Siphon

THE average windshield wiper goes bad long before it is worn out. Constant contact with the surface of the glass puts a kink in the rubber edge so that it will not bend back and forth to clean the glass as it should. Fig. 1, below, shows how to avoid this deterioration.

Take a small piece of sheet metal and bend it into a triangular shape. Then cut or file small notches in the upper edges. When the windshield wiper is not in use, the sheet metal piece is slipped over the wiper so that the hinge pin will rest in the notches and the rubber will be held away from contact with the glass. This will prevent the rubber from taking a permanent set.

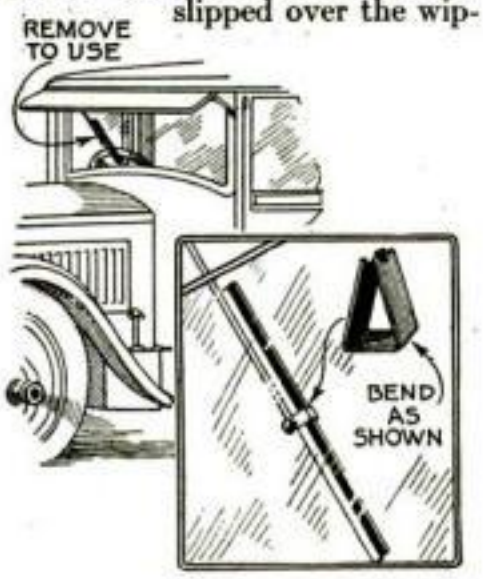


Fig. 1. Small metal guard stops warping of rubber windshield wiper.

Convenient Tool Pockets

THE coach type of auto body usually has the front seats so they can tip forward to give access to the rear seats. Hinges support these seats at the front and feet are provided at the rear so that there is a space between the bottom of the seat and floor of the car. You can utilize this space for two handy tool pockets, as shown in Fig. 2. Each pocket should be fitted with a flap held tight either by rings and hooks or by snap fasteners. The arrangement of the tools and the number of pockets will be governed by the space available.

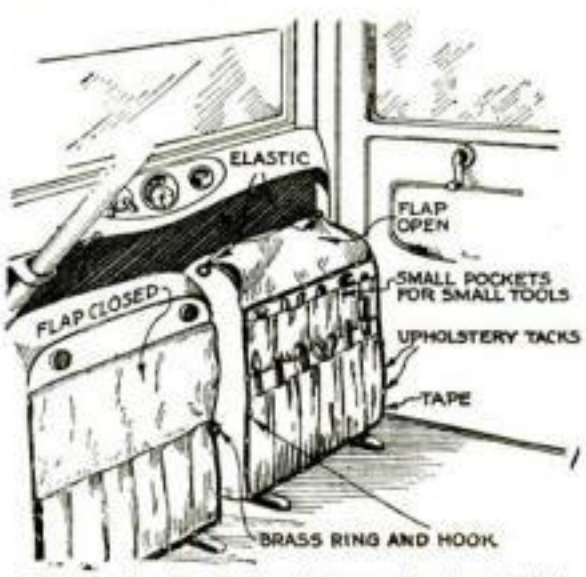


Fig. 2. Handy tool pockets can be rigged with canvas flaps under coach-body seats that tilt up.

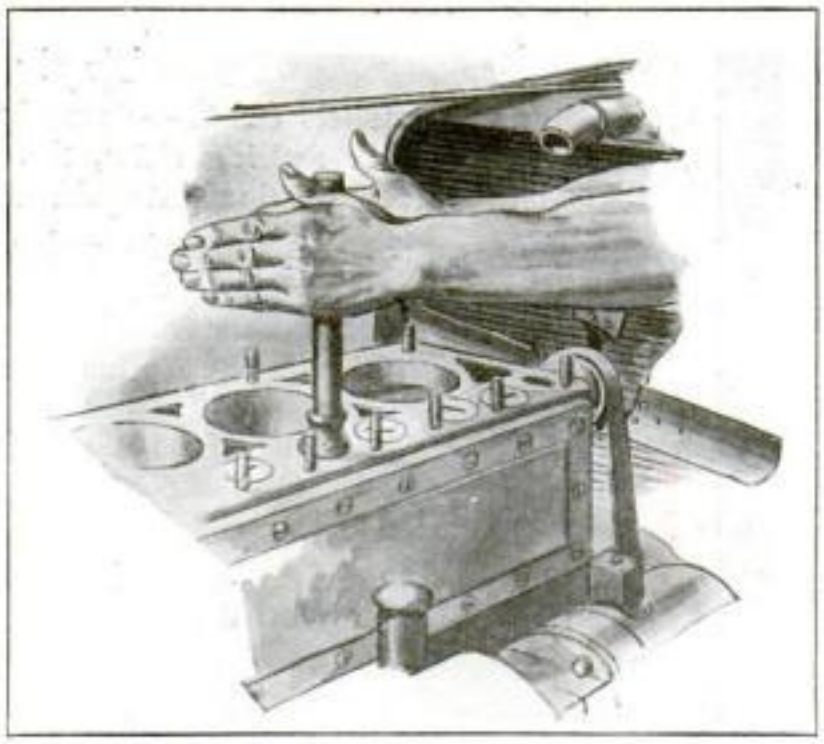


Fig. 3. Cut off a plumber's force cup to fit the valve head and you have a simple grinding device.

Trick Valve-Grinding Tool

AN ORDINARY plumber's force cup, such as is used for clearing clogged drain pipes, can be fashioned into a useful valve-grinding tool. The lower part of the rubber cup is cut off so that the diameter of the remaining portion is smaller than the diameter of the head of the valve. Pressing the cup tightly against the valve will cause the rubber to adhere so the valve can be rotated and lifted from time to time, as shown in Fig. 3.

Ten Dollars for an Idea!

R. L. Ogden, of Edgewater, Colo., wins this month's $10 prize for his suggestion of a valve-grinding tool, as shown in Fig. 3. Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions used are paid for at the usual rates.

A Self-Starting Siphon

INSTEAD of sucking rubber hose to start gasoline siphoning out of a tank, construct the neat siphon shown in Fig. 4. Bend a piece of brass or copper tubing into a U shape. To one end attach a rubber bulb like photographers use. To the other attach a piece of hose. Then drill a hole in the tube at the bend. Insert the rubber tube in the tank and squeeze the bulb. Press your finger tightly over the hole and release the bulb. Remove your finger and gasoline will flow from the hole in the pipe. The hole must be below the level of the gasoline in the tank.

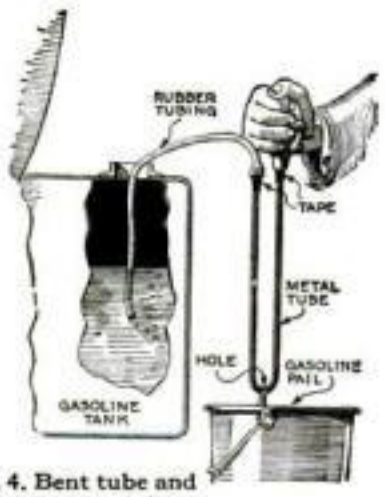


Fig. 4. Bent tube and bulb a handy siphon.

Running-Board Tire Rack

FIGURE 5 shows a convenient and simple running-board tire holder that can be made from a block of wood, some strap iron, and five bolts. As shown, the arrangement is for a rim fitted with four lugs, but it will work with other numbers of lugs, if necessary. Make sure that the tire is held rigidly in place.

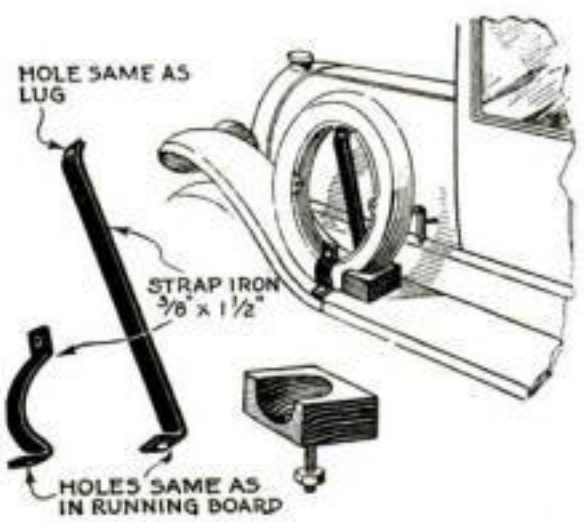
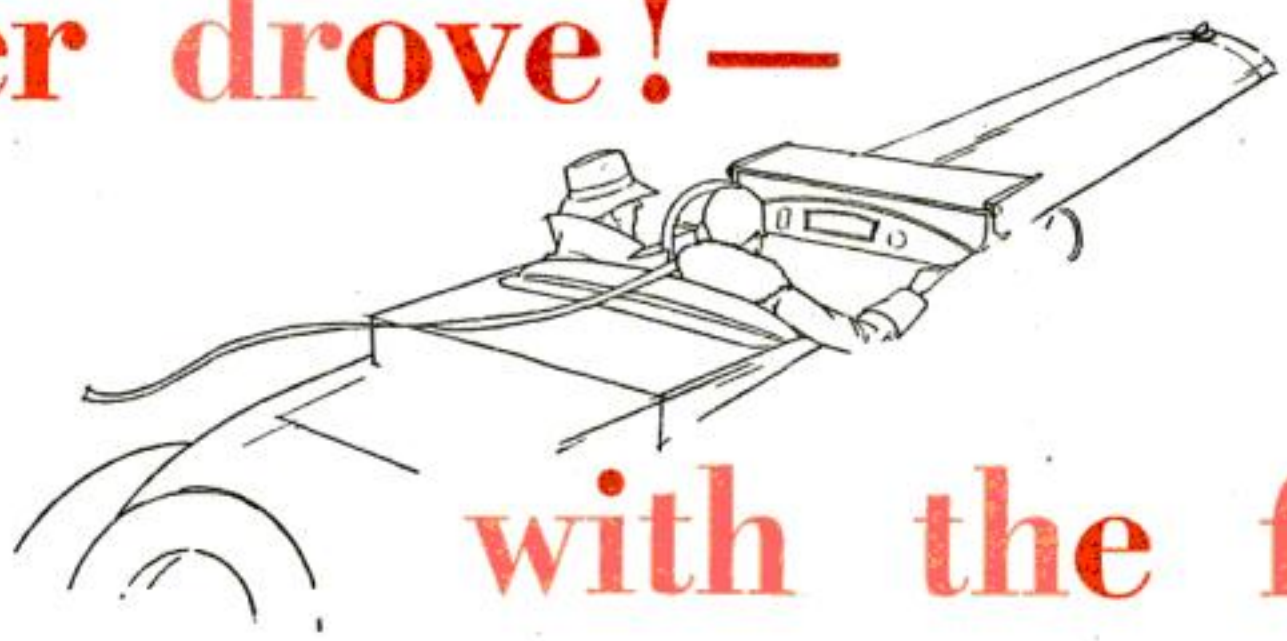


Fig. 5. A wooden block, strap iron, and five bolts compose this running-board tire holder.

We offer you 30,000 of the finest miles you ever drove!—



with the first-year feel in every mile

We announce the New Mobiloil—an oil so startling in its performance that the superlative statements we are ready to make about it are actually conservative.

For example, when we say that with regular draining and refilling, plus common-sense care, this New Mobiloil will keep the first-year feel in your new engine for at least 30,000 miles, the facts are that in a great many engines the New Mobiloil has kept the first-year feel for more than twice this distance.

Repeated road and laboratory tests have proved that use of this New Mobiloil commonly assures from 10% to 30% more power than other oils generally sold for the same motor.

Under high speeds you will find, as our road tests have repeatedly shown, that this New Mobiloil stands up better and consumes more slowly than other oils . . . and it is an established engineering fact that the oil which lasts longest and stands up best at high speed also lubricates best at any speed.

Try this New Mobiloil. It will help save your good engine from growing old before its time. Mobiloil—the World's Quality Oil—is made by the Oldest and Largest Specialists in Lubrication.

VACUUM OIL COMPANY

Makers of high quality lubricants for all types of machinery

the New Mobiloil

Dressing Up Your Photographs

An Expert's Method of Preparing Prints for Framing—How to Emboss the Mounts

By WALTER E. BURTON

"HENRY, I wish you would take this photograph of Mary Ellen down town and have it framed," Mrs. Webster said to her husband as he started for the office.

"I'll get a frame and put the picture in it myself. That will be cheaper," Henry replied. "Where's the yardstick?"

He measured the picture and found it to be approximately 7½ by 10 inches.

"I'll get a frame two inches larger all around," he remarked, as he jotted down the figures. "I like a picture mounted so as to have a white border around it."

That evening Henry framed the photo. He covered the entire back with paste, carefully centered the picture on a piece of stiff white paper cut to fit the frame, let the paste dry for an hour, and then tacked the picture with its mounting in the frame.

"The picture doesn't look altogether satisfactory, does it?" Mrs. Webster diplomatically hinted a few days later. "I wonder why it is so wrinkled."

"It's warping because of the paste," Henry announced, after carefully inspecting his masterpiece of framing. "I guess I didn't do such a good job of it."

"I WAS looking at some pictures in an art store window today and saw several that were placed in a little panel in the mount," Mrs. Webster said. "Could you fix this one like that?"

"I know what I'll do. I'll go over and see Jack this evening. He belongs to a photographic club or something, and knows all about mounting pictures for exhibitions and the like."

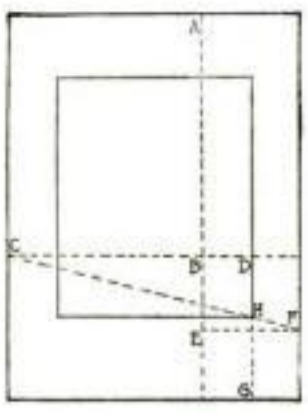
As Henry anticipated, Jack was glad to explain his methods. His first suggestion was that Henry use for the 8 by 10 in. print of Mary Ellen a mount about 12 by 16 in., the material for which could be obtained at almost any art or photographic store.

"Be sure that it is fairly heavy so that it will not wrinkle easily," Jack warned. "And you must give considerable thought to the proper method of trimming your print."

"But I always hesitate to trim a picture because I am afraid of spoiling it," Henry objected.

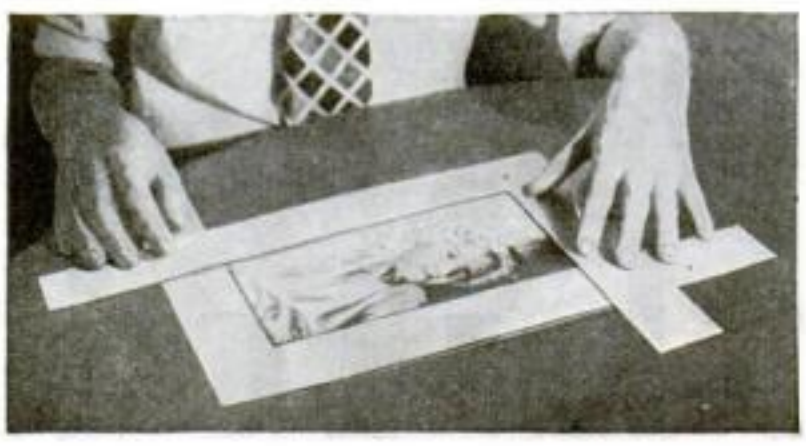
"You can remove that fear by cutting two L-shaped pieces of cardboard," Jack assured him. "By laying them on a print so as to form an adjustable rectangle, you can experiment to your heart's content. When you have found the most attractive portion of the picture and have eliminated undesirable details, blurred edges, parts out of focus, too large patches of sky or foreground, and the like, you can proceed to trim your print.

Mary Ellen's portrait on embossed mount with a narrow band of underlay showing.



How to Mount Photos

If the print requires trimming, two L-shaped pieces of cardboard are laid over it as shown below and shifted until the best way to crop the picture has been found. The trimming is done with a safety razor blade or a knife as illustrated above. How to place the print on the mount is determined as shown by the diagram at the left. The mount itself is embossed with a buttonhook or other blunt instrument, as illustrated in the uppermost photograph of this group. The underlay is placed as indicated at the right.



Usually you will have no difficulty in obtaining a picture that does not lean to one side if you line up one of the edges with a prominent horizontal or vertical line in the picture, such as the edge of a building or the horizon of a sea view.

"When you actually begin trimming, do it carefully, so as to obtain perfectly clean-cut edges and square corners. An old razor blade is excellent for trimming, and it should be used with a steel ruler or one that has a metal edge. An old magazine, a piece of glass or zinc, or other flat surface makes a suitable trimming support. The corners of the picture can be made square with the aid of a draftsman's ninety-degree triangle. Or, if you have a number of prints to frame, you can make a scale on each of the inside edges of the L-shaped masking pieces, and it will then be a simple matter to obtain a true rectangle."

He explained that a photograph or other picture should never be placed in the exact center of the mount; it ought to be arranged so that the border space on each side is of the same width and that at the bottom is wider than at the top. To determine the most suitable position of any sized print on almost any sized mount, first trim the mount so that the corners are square. Then place the print in the upper left-hand corner, as shown by dotted lines in the diagram on this page. Now make a pencil dot at the two lower corners and the upper right, *A*, *B*, and *C*. With the ruler find the (Continued on page 118)

C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced, patented C & L blow-torch improvements. It also has a red handle with a gold stripe. Sure sign of satisfaction.

You're investing in better and longer performance when you buy a Clayton & Lambert

Ⓢ

AN EXPANDED gas orifice makes a blow-torch a piece of junk. And it's the easiest thing in the world to enlarge the orifice in an ordinary torch. But a No. 32 Clayton & Lambert blow-torch has an orifice that *can't be enlarged* — no matter how carelessly or how tight you close the valve. It's a patented Clayton & Lambert improvement—one reason why you get longer service when you buy a Clayton & Lambert.

In addition to being non-spreading, the orifice will not clog. As you close down the valve the carbon cleans out automatically. The improved orifice is but one of *many* Clayton & Lambert advancements. Every bit of mechanism is designed to give you quicker, better action. Inside and out, a Clayton & Lambert is built for long, strenuous use. Where a hard bump might occur, a Clayton & Lambert is reinforced. Wherever extra protection should be—you'll find it in Clayton & Lambert.

As an example, all Clayton & Lamberts are made *non-explosive* by a patented method of building the fittings into the tank. The vaporizing chamber is another Clayton & Lambert feature. Its special vein system gives you quicker heat—more heat—and cuts down your fuel bills. You can't see these things which Clayton & Lambert have done to give you the blow-torch you want. They're inside—in the "works," the important part of a torch. But they're there—along with numerous other refinements. They account for superior performance and durability. And that's why Clayton & Lamberts are the most popular torches in the world.

You'll know a Clayton & Lambert by the red handle with a gold stripe.

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly. Look for the gold-banded, red handle.

CLAYTON & LAMBERT

MANUFACTURING CO., Detroit, Mich.

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

One Bench That's Big Enough

Designed for Home Workshop Use, It Is of Heavy-Duty Type Yet Easy to Build

By

E. E. ERICSON

A man-size bench of the carpenter's type for the amateur mechanic who does much woodworking and repairing.

EVERY amateur woodworker and every man who does much household repair work needs a fairly large, rigid workbench. Wherever there is room available—in the basement, garage, or large attic—the bench illustrated will make its appeal to the worker because of its strength, durability, and simplicity of design and construction.

A bill of lumber is the first concern of anyone who wishes to construct this bench. The wood can be obtained at any lumberyard. Hard (yellow) pine can be used throughout with the exception of the leg at the vise and the vise jaw, which should be made of maple or a similar hardwood. The top also will be better if of hardwood, but the construction will be a little more difficult.

For convenience two separate lists are given (on page 130): first, the lumber order as it may be turned over to the mill or lumberyard; second, a stock bill showing the actual widths and thicknesses of planed lumber as it comes from the mill and the finished sizes to which the material must be cut by the worker himself. The pieces may vary slightly from the dimensions stated, but the variations will not materially affect the finished workbench.

The following order of procedure is suggested:

1. Cut the four legs to the required length. (The length indicated in the drawing, 30 in., is a good, standard height.) Attach the vise-screw nut.

2. Cut the two upper cross rails for the ends to the length given.

3. Cut lower rails.

4. Hold all four legs together with a hand screw or other clamp in such a way that their outer edges are exposed. With pencil and square, draw crosslines to indicate the location of the cross rails. The upper rails act also as backs for the tool compartments.

5. Now nail up the two ends for the bench, using glue in the joints for added rigidity, and not less than three eight-penny box nails or common nails in each joint. Check for squareness with a steel square.

6. Glue and nail the piece of 13/16-in. maple on the face of the vise leg as shown in the drawing. This should not be cut to length at this time, but should be trimmed even with the surface of the top after the top is applied.

7. Cut the two aprons to the proper length (first checking the length of the pieces for the top). Cut away from one of them the part displaced by the piece of maple facing on the front leg previously mentioned; then glue and nail them in place. Use the square frequently while nailing up the frame.

8. Take the actual measurement for the stretcher or shelf that runs between the two lower cross rails. If desired, this can be made to overlap a little at each end for effect. This wide stretcher will serve as a shelf for tools and materials.

9. Cut out the place for the drawer on the front apron. This is best done by boring holes in two diagonal corners of the rectangle to be taken out and starting the cuts with a compass or keyhole saw.

10. Fit one of the 9-in. boards at each side of this opening, making them also support the top at these points. Before fastening these boards, nail on them the slats which form supports for the drawer.

11. Fit the shelves in the ends, nailing them to the under edge of the cross rails or against these rails as may be determined by the width of the boards and the distance the aprons extend.

12. Joint (plane the edges) and glue up the two planks for the top. Use four ½-in. dowels for the joint. Care must be taken to mark accurately for the dowels; use a marking gage, knife, and square.

13. Trim the top to the length of the aprons and fasten it with 2½-in. No. 12 flathead screws. First bore a ½-inch hole ½ in. deep to receive each screw; then drill a hole right through into which the screw thread will slip easily. Hold the top in place, drill 5/16-in. holes into the rails, drive the screws, and glue plugs into the ½-in. holes.

14. Cut the board for the bottom of the tool trough for length and also for width, if necessary. Nail this in place and nail on the strip along its outer edge.

15. Form the vise jaw to required shape, making it about 7 in. at the top and 4½ in. at the bottom. Plane a bevel on the outer edges of this, but do not attempt to finish the top end of it until after the vise screw and the follower have been fitted.

16. Clamp the vise jaw in place with the upper end protruding slightly above the top. Locate center of vise screw to coincide with the flanged nut center; bore a hole to allow screw to pass freely, and fasten collar.

17. Now tighten up the vise and bore a series of holes through both jaw and leg in one operation for the follower or "lock strip." These holes should form a slot nearly the full size of the cross section of the follower, that is, 13/16 by 3 in. Then chisel out for a tight fit in the jaw and a sliding fit in the leg.

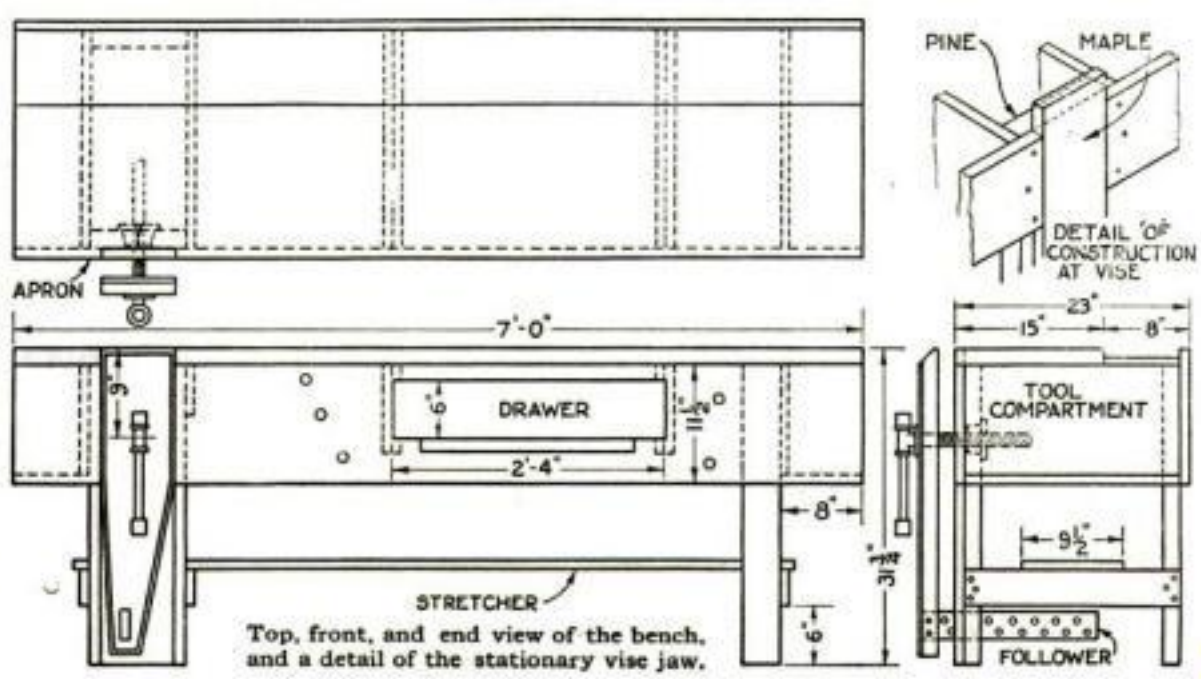
18. Bore a series of holes ½ in. in diameter through the follower in a zigzag pattern about 1 in. apart, as shown.

19. Glue and dowel the follower into the vise jaw, being particular that it is put in square with the jaw.

20. Tighten up the vise, plane off the end of the jaw, and run a bevel on the front side of it.

21. Make the

(Continued on page 130)



Top, front, and end view of the bench, and a detail of the stationary vise jaw.

NOW, *for faster, easier cutting* New-Model Disston Hand Saws

1—Lighter Blades *—for easier cutting*
2—Narrower Blades *—save strength*
3—True-Taper Grind *—for faster cutting*
4—Thin, yet Stiff *—for true running*
5—New Handles *—give better balance*
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Never until now could you get blades so thin, so stiff, so light, to cut fast and run true.

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THE Saw Most Carpenters Use now comes to you in entirely new models, improved in every feature.

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They have better clearance, better balance, better steel, better temper, and will give you better service.

They are *lighter*, with blades *thinner*, yet *stiff*, always the goal of saw makers, first achieved by Disston. Now made possible only by Disston Steel.

And you know this: *The thinner a blade is, if it is stiff, the better it cuts and the easier it is to use.*

Get This Helpful Book

Every saw user will enjoy reading "The Disston Saw, Tool and File Book," an illustrated manual on the selection, care and use of tools. It tells how to file and set saws and contains much other helpful information. The coupon below will bring it.

The new Disston D-8 Lightweight Saw weighs only 1 lb., 7 oz. in 26-inch length. Less weight to push: less work for you. Thinner, yet stiff, it cuts faster and easier, like all the fourteen other hand saws in the new Disston line.

Use the right saws and files in the home workshop

Good tools, and correct tools, are required for good work. These are some of the Disston Tools needed in the home shop.

No. 4 Back Saw—Handiest of all small saws. Fine teeth and stiff back enable you to do the smooth, even cutting that is so necessary for accurate work in cabinet making, etc. Can be used in mitre box. The 12-inch size, 3 inches under back, with teeth 14 points to inch, is most popular. $3.00.

No. 68 Dovetail Saw—Used in pattern and cabinet making where extra thin saw with fine teeth is needed. Eight-inch blade, 17 points, is most popular. $1.60.

D-3 Filing Guide and Clamp—Enables any one to sharpen saws correctly, filing each tooth at the same angle. Adjustable for both rip and cross-cut saws. Complete with directions. $6.50.

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Disston Files—File your saws with Disston Special Extra-Slim Blunt Saw Files. Special teeth, cut better; parallel sides; extra-slim; Disston-made steel. 5-inch, 20c; 5½-inch, 20c; 6-inch, 25c; 7-inch, 30c. There is a Disston File for every purpose.

No. 120 Acme Cabinet Scraper—Needed on every work bench. Made from Disston Saw Steel, high tempered, ground even gauge, dressed on edges. Made in all needed sizes, 2⅛" and 2⅜" wide and 5" and 6" long being standard. 25 cents and up according to size.

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A Light Hand *on the* Wrench

Often Prevents the Serious Distortion of Work Held in Lathes or Other Machines, According to HENRY SIMON, *Expert on Better Shop Methods*

IF THERE are a dozen ways of distorting work held against the faceplate or machine table, there are at least as many of doing the same thing with the chuck.

Every mechanic is familiar with the difficulties of holding a thin ring without causing it to go out of round, but it is not so generally realized how thick a ring or tubular part may be and yet be distorted by the pressure of chuck jaws under certain conditions.

Any good lathe chuck is capable of exerting powerful pressure, which may cause an appreciable deformation in a ring such as that shown in Fig. 1 at *A*. This deformation is usually increased by expansion due to heat generated in cutting. While the effect of heat will not be treated in this article, it should be remembered that expansion from heat will produce a condition similar to that which results from excessive tightening of the chuck jaws.

It should be observed that the deformation of the ring is not the same as the reduction of the diameters in line with the jaws. As the circumference of the ring remains practically unaffected by the pressure, some portions must be pushed outward by about the amount that other portions are displaced inwardly, as happens in converting the circle in the diagram at *B* into a square of equal perimeter. The error is therefore practically doubled, as shown in view *C*.

A FIRST cousin to this type of trouble is that resulting from boring out solid work to a shell, as in Fig. 2 at *A* and *B*. Being solid, the work is strongly clamped at the beginning to hold it against heavy drilling and boring cuts. As the job proceeds, the heat generated expands the work as well as the chuck jaws, setting them still harder against the work, which is now hollow and has a wall of constantly decreasing thickness. By the time the job is done and the work removed from the lathe, the hole is out of round as at *C*.

Even where the wall of the work is so thick that it would seem unlikely that the jaws could cause any change, the work may yet be deformed because of the uneven bearing of the jaws on the surface of the work. At *A* in Fig. 3, the slight projection *a* on the rough casting has the effect of concentrating the pressure at that point when the jaw is tightened as at *B*, with the result shown at *C*.

"It was large enough while in the lathe chuck," said Old Bill, "but now it has sprung out of shape and the hole is no longer truly round."

OLD BILL stopped at a 20-in. lathe where one of his apprentices was boring a small eccentric strap for a hoisting engine. He observed that the machining was complete, and at the boy's request checked the dimensions and found that they were correct. The parts should go together without trouble.

But—something caught his eye which led him to suspect trouble. He instructed the boy to remove the strap from the chuck, take it apart, and assemble the halves about the eccentric.

Much to the apprentice's consternation, the halves would not close about the eccentric, and he exclaimed, "I am sure that I had the bore large enough!"

Old Bill could not resist a temptation to smile at the boy's expense, but said kindly, "It *was* large enough while it was in the lathe chuck, but it is not the same shape now as then, for you had it clamped so tightly that you sprung the casting in at four points, and the intermediate points sprang out, which was the condition when you bored the hole round. Now it has sprung back to the original shape, and the hole is no longer round, but has a wavy outline, like this—" Old Bill made a rapid sketch with chalk on the bench.

In this manner was one of Old Bill's apprentices introduced to the mysteries of elasticity in metals, a property discussed in the accompanying article.

An analogous effect results where the registering surface of the work is slightly tapering, as at *D*, Fig. 4, or by tapering surfaces or play in the chuck jaws, as at *E*.

Happily, the remedies for these troubles are simple. The main thing to keep clearly in mind is when and how the various distorting agencies are likely to operate. The first rule, of course, is to avoid unnecessarily heavy clamping, and to remember that a solid part may become a frail object by the time it has been bored and turned.

IN THE absence of cutting compound, the simple rule of allowing the work to cool before taking the finishing cuts—not partly, as is too often the case, but completely—will go far towards preventing trouble from pressure due to heat expansion. Pouring cutting compound over the hot part and into a pan underneath is a quicker way, but with delicate parts such sudden cooling is likely to set up strains in the metal which may be troublesome later.

When a finished piece of work is to have thin walls, yet must be made from a solid piece, the stock should be clamped hard at first so as to remain secure under the heavy roughing cut and then be reset with lighter pressure for finishing. This resetting may often seem inconvenient, yet it will pay in the end, especially as it will also minimize the results of other stresses released during cutting.

In Fig. 5 is pointed out one way that may lead to trouble on work held between centers. With the dog placed that near the end of the piece, and with only a point bearing on the screw against two line bearings in the vee as at *A*, the condition shown exaggerated at *B* may easily occur. The resulting motion of the work during the grinding operation is shown at *C*, and the result at *D*. Though disalignment of the center may be very slight, yet, on an accurate part such as that shown, the effect on the truth of the flange may be painfully noticeable.

Another and more common, yet frequently unsus-

(Continued on page 98)

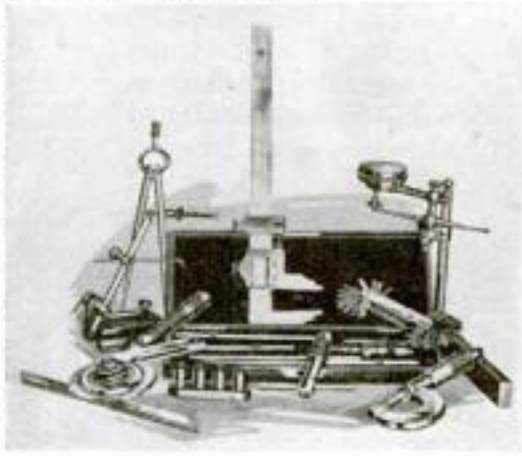
They use Starrett Tools whenever things have got to be right

TAKING down a "Whirlwind" or a "Wasp" for major overhaul comes only at twenty, even thirty thousand mile intervals. When it *is* done, it is done with a thoroughness that has for its basis the heavy responsibility of assuring unfaltering performance.

Aircraft motor manufacturers and transport operators alike rely on the accuracy and dependability of Starrett Tools.

You, too, want Starrett accuracy and dependability, no matter whether you use tools for serious work or as a hobby.

You're not satisfied with anything but the best.



Whenever you buy a precision tool, hacksaw or steel tape, see that it bears the Starrett name. Your dealer will gladly show you genuine Starretts.

Let us mail you a free copy of the great Starrett Catalog No. 24 "W" illustrating and describing more than 2500 Starrett Tools.

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Use Starrett Tools

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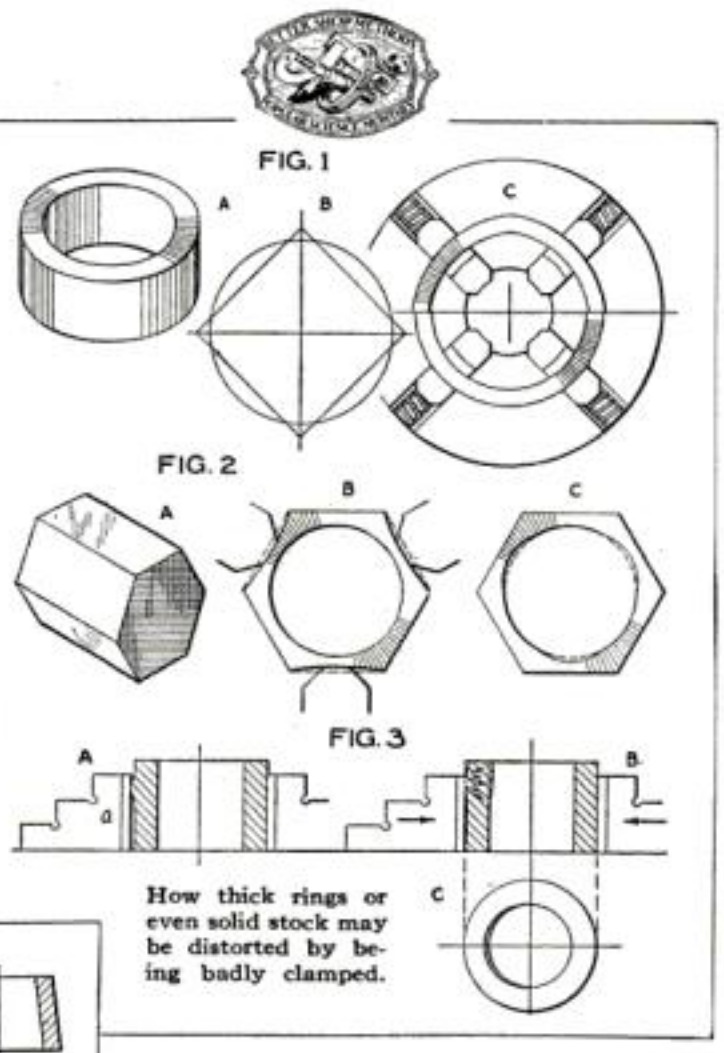
A Light Hand *on the* Wrench

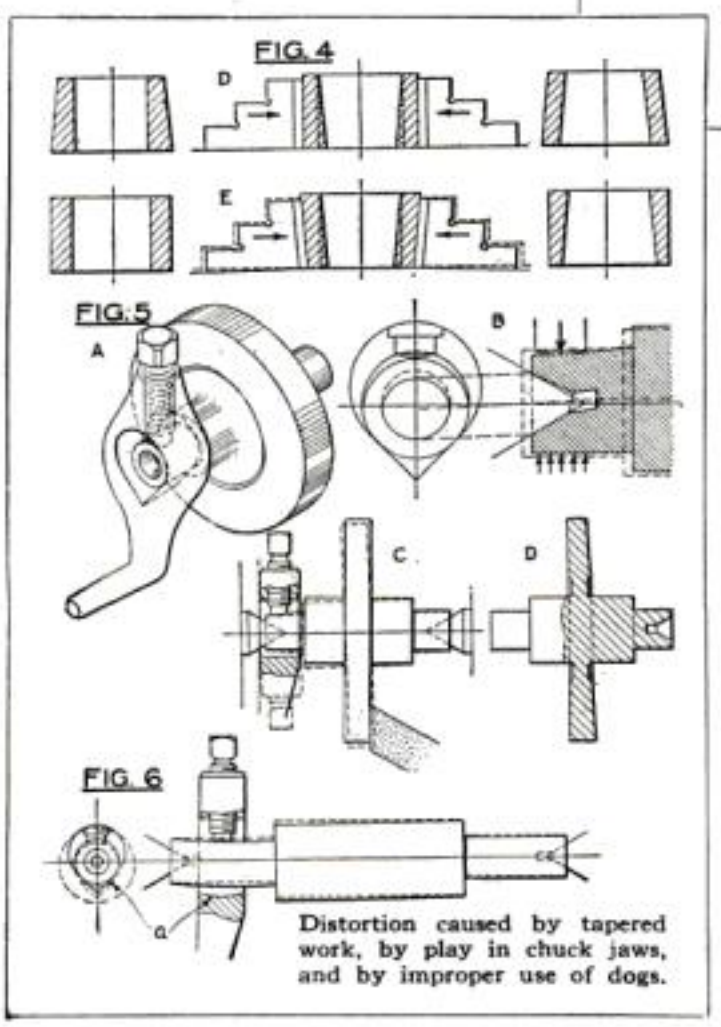
(*Continued from page 96*)

pected, cause of trouble is shown in Fig. 6. Here the vee in the dog is slightly hollow, as indicated at *a*. As a result the part bears only at the outer ends and the screw may bend it as shown, displacing the axis.

Care, watchfulness, and forethought, together with a light hand on the wrench, are here also the larger parts of the solution. Another point, and one frequently sinned against, is the proper selection and size of the dog. For the mechanic who likes to put his odd moments to use, a simple and useful "trouble-proof" dog for light work is shown in Fig. 7. This is easily made from some scraps of square cold-rolled steel and is so designed that it cannot cause any distortion, since it always centers evenly on the work all the way around. A few dogs of this kind are easily made



How thick rings or even solid stock may be distorted by being badly clamped.



Distortion caused by tapered work, by play in chuck jaws, and by improper use of dogs.

and will be found a help in grinding many kinds of small work.

The strains we have so far been considering in this article all were in the nature of *bending*. Is it possible under ordinary working conditions to *compress* metal so that trouble will result? To illustrate the difference by the diagram in Fig. 8—knowing that we can distort the part *a* when held as at *A*, are we apt to change its shape by compressing the metal as at *B*? Some mechanics will say "yes" to this question; others will undoubtedly say "no." What is the truth?

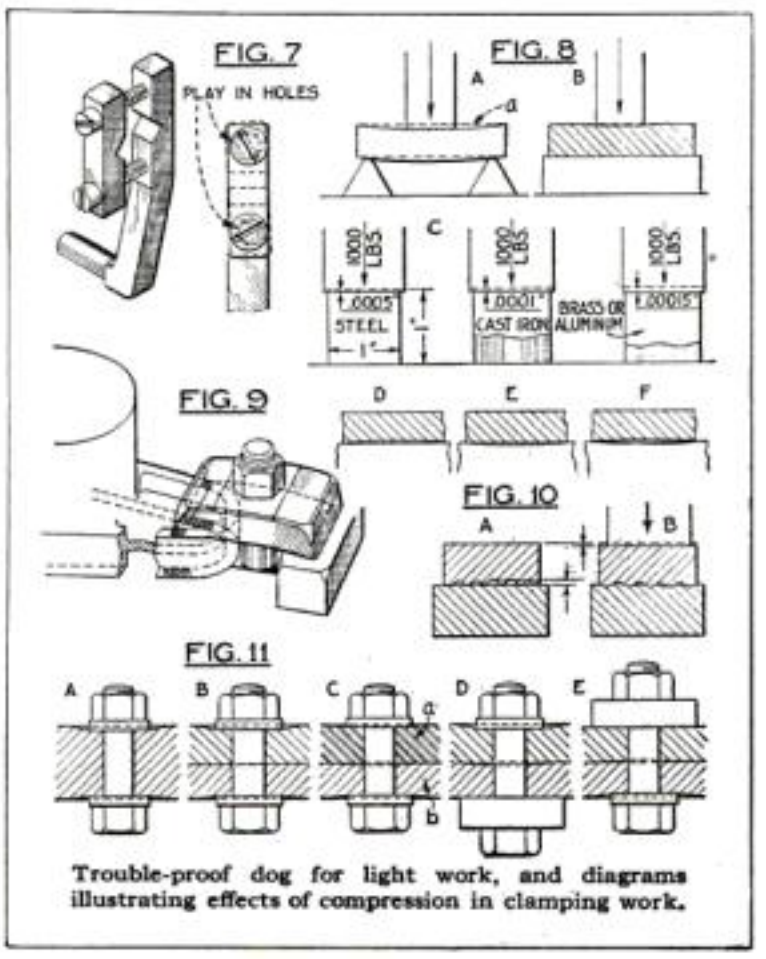
It may be said at once that the truth, though it lies between the two extremes, is much nearer the "no" side. Distortion may occur as the result of pure compression, but it will rarely amount to enough by itself to make any real difference. This will be clear when we look at the diagrams *C* in Fig. 8, where it will be seen, for instance, that a pressure of 1,000 lbs. would be required to compress a solid cast-iron cylinder 1 in. in diameter and 1 in. high by as little as .0001 in.

It will be understood that when we speak of compression, what is meant is only the elastic "give." Enormously greater pressures would be required to deform the material permanently. The troubles sometimes thought to result from compression are almost always due to bending strains caused by a dent or "dish" in the surface of the work, as at *D*, or the same condition in the faceplate, as at *E*, or both, as at *F*.

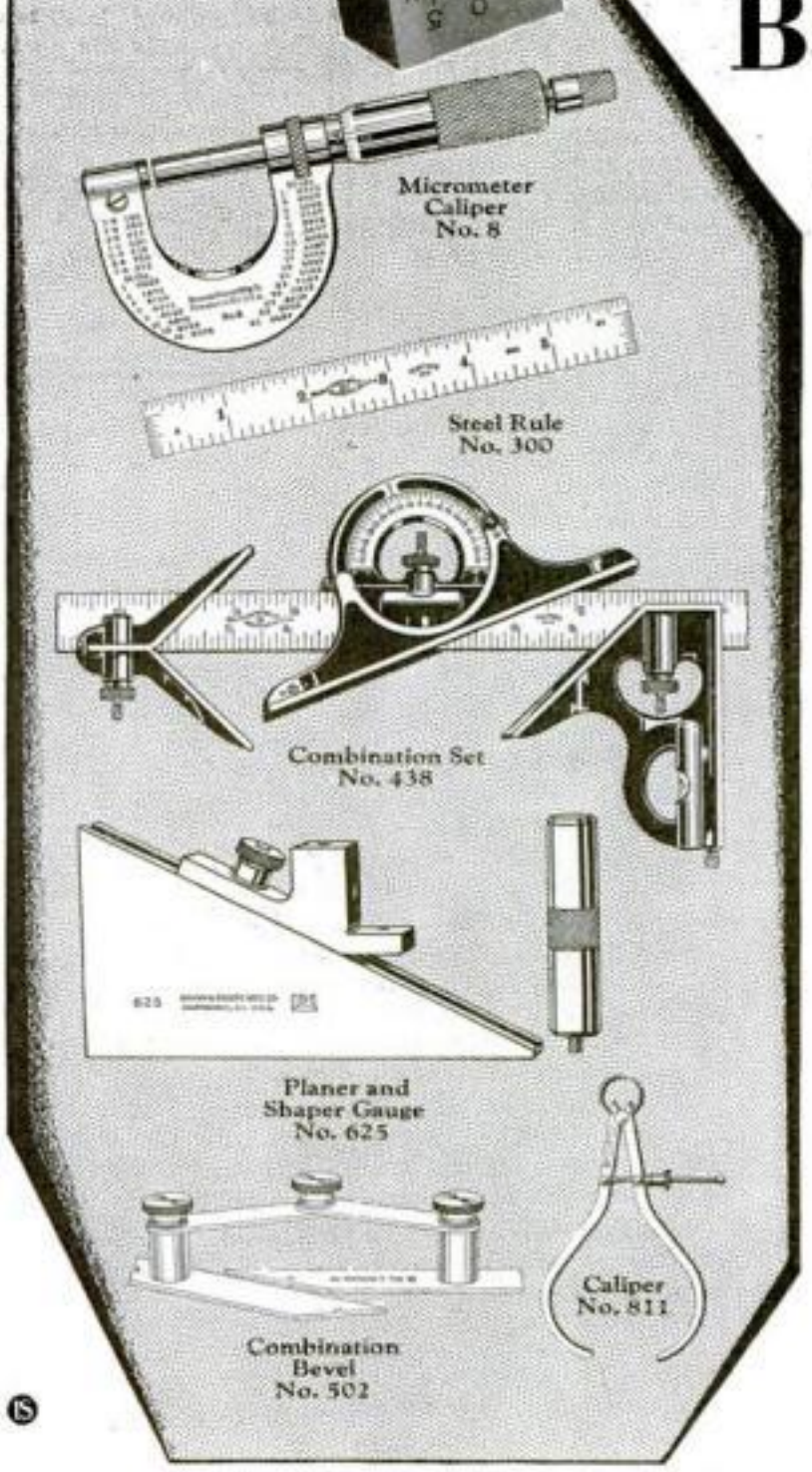
IN FIG. 9 is shown an instance where a part may be distorted enough by pure compression to produce an error. With the registering surface of the part and the working surface of the clamp as narrow as they are, a force of, say, 200 lbs. on the clamp becomes a pressure of thousands of pounds per square inch, so that the part will be compressed centrally by several ten-thousandths. It should be added, however, that any such pressure as 200 lbs. on the clamp, though it is often used, is far in excess of that necessary for a finishing cut. A pressure of 50 lbs. per clamp would be ample.

One way in which compression is frequently enabled to get in its work where one would not suspect it is pictured in Fig. 10. Viewed under a strong magnifying glass, the smooth surface of the faceplate or machine table, as well as that of the work, looks like a plowed field. Magnified a good many times, a cross section of either work or table would look something like at *A*, although in practice the lower surface will almost always be in the same condition, so that the pieces touch each other only at a number of points marked by the high ridges of innumerable intersecting furrows. Under such conditions a moderate force may be enough to compress the parts into each other to the extent of a few ten-thousandths.

It may be well to conclude by considering how compression acts on two flat parts under different conditions, as by the action of the bolt shown in Fig. 11. With the bolt ends equal, a plate of solid metal is compressed equally from both sides as at *A*. The effect is the same with two plates of the same material, as at *B*, the plane of contact remaining straight. This is not the case when one of the members is harder, as the steel part *a* at *C*. Here the softer cast-iron member *b* is compressed from the bolthead and from the steel plate, and a bending effect is thus produced in the latter. A similar bending strain results when a larger hardened washer is used against one or the other of two plates of the same material, as at *D* and *E*.



Trouble-proof dog for light work, and diagrams illustrating effects of compression in clamping work.



Better Workmen -- Better Tools

The good workman of today who takes pride in his tools has replaced the workman of the old adage who blamed poor work on his tools.

Present day production sets such a premium upon speed and accuracy that only the worker with reliable, well-made tools can stand the pace.

The Brown & Sharpe Die Maker's Square (No. 552) shown in the illustration is provided with straight or offset blade. Its handy design gives it countless uses for measuring drafts, tapers, etc. This and 2300 other fine tools are described in Small Tool Catalog. Your hardware dealer will supply you with a copy, or you can get one free from us. Address Dept. P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

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EASTMAN KODAK COMPANY *Announces*

$30,000.00

for Amateur Picture-Takers Only . . .

Read these simple conditions

1 Any resident of the United States and its dependencies or any resident of the Dominion of Canada is eligible, excepting individuals and families of individuals engaged, either directly or indirectly, in the manufacture, sale, commercial finishing or professional use of photographic goods. This contest is strictly for the amateur. Contest starts March 1, closes May 31, 1929.

2 Any Kodak, Brownie, Hawk-Eye, or other camera producing negatives not larger than 3¼ x 5½ inches (postcard size) and any brand of film, chemicals and papers may be used in making pictures for this contest. A contestant need not own the camera. The finishing, of course, may be done by his dealer.

3 Both ordinary contact prints, and enlargements not to exceed 7 inches in the long dimension, are eligible; but,

4 In the Special Enlargement Competition, prints having a long dimension of not less than 9 inches or more than 17 inches, are eligible. Entries in the Enlargement Competition are eligible for Special Enlargement Prizes only.

5 Prints shall be unmounted, but an entry blank shall be enclosed. Use the accompanying blank, obtain others from dealers; copy the form, or write Prize Contest Office, Eastman Kodak Company, Rochester, N. Y.

6 An entrant may submit as many pictures as he pleases and at as many different times as he pleases, provided that the pictures have been made on or after March 1, 1929, and that they reach the Prize Contest Office, Eastman Kodak Company, Rochester, N. Y., by the specified closing date.

7 Entries in the Child Picture Contest to be eligible for the March award shall be received at the Prize Contest Office, Eastman Kodak Company, Rochester, N. Y., by midnight of March 31, 1929; and for the April award by midnight of April 30, 1929. The child in the picture shall not have passed the twelfth birthday.

8 A picture that is to be considered in the Child Picture Contest must be so designated on the back.

In the case of other pictures, however, the entrant need not, unless he wishes to, specify into which of the classifications his pictures should go. The Prize Contest Office reserves the right to change a classification for the benefit of the entrant. If not classified on the back by the entrant, the pictures will go into the classes in which they are most likely to win.

9 Each prize-winning picture, together with the negative, and the rights to the use thereof for advertising, publication, or exhibition in any manner, becomes the property of the Eastman Kodak Company.

10 No prints can be returned, except that entries in the Enlargement Competition will be returned upon request. All mailings are at the owner's risk.

Do not send negatives until they are requested.

11 The decision of the judges will be final. In the event of a tie, the advertised award will be paid to each of the tying contestants.

12 All pictures will be judged 50% on subject interest; 25% on composition and arrangement; 25% on photographic excellence (correctness of exposure, etc.).

13 Mail pictures to Prize Contest Office, Eastman Kodak Company, Rochester, N. Y.

14 An entrant may receive only one prize. In case the judges select any entrant for more than one award, he will receive the largest thereof. If he wins, for example, a $100 state prize in the Child Picture Contest, and if either the same print or another of his prints in the General Contest wins an award larger than $100, he will receive the larger amount. The Eastman Kodak Company will consider the purchase of desirable pictures even though not prize winners.

15 Winners of the state prizes in the Child Picture Contest for March will be notified as soon as possible after March 31, and for the April Contest as soon as possible after April 30, 1929; winners in the Special Enlargement Competition and all other classifications will be notified as soon as possible after May 31, 1929.

PRIZES

Grand Prize of		$2,500.00
11 *prizes of*	500.00	*each*
11 *prizes of*	250.00	*each*
125 *prizes of*	100.00	*each*
275 *prizes of*	10.00	*each*
800 *prizes of*	5.00	*each*
1,223		$30,000.00

$11,400 in Special Monthly State Prizes

For the most interesting picture of Children submitted during March and April, $100.00 will be awarded in each state of the United States and each province of Canada. $11,400.00 in all. Read the details below.

THIS is a contest for *everyone*. It is easy to enter—and there are 1,223 money prizes. Perhaps you have not taken more than a half-dozen pictures in all your life—you may never before have held a camera in your hands—yet *your* entry may please the judges most. And regardless of the make of camera you use—from an inexpensive Kodak, Brownie or Hawk-Eye on up to a camera of the costliest kind—your chance to win is just as good.

This prize money will not be awarded for technical skill alone. You do not need to be an experienced picture maker to win. The bulk of this $30,000 will go to those who send in the *most interesting pictures* in each of 10 different classifications. Now is the time to get your camera into action. The opportunity to win a cash prize of anywhere from $2,500 down is knocking at your door.

Here is the way in which the $30,000 prize money is to be distributed. You may enter for each and all of the classes. Send in as many entries as you like. The more pictures you submit in this contest the better is your chance of being numbered among the 1,223 fortunate ones to win.

GRAND PRIZE—For the Best Picture of Any Type— The best picture of all of those submitted in the following classifications will be awarded a grand prize of $2,500.

STATE PRIZES—For Child and Baby Pictures— $11,400 will be awarded for the pictures showing the most interesting children . . . in both March and April $100 will be given for the best child picture in *each state* of the United States and *each province* of Canada,* making 114 prizes in all.

*District of Columbia counts as one state; Hawaii, Alaska and all other U. S. dependencies combined count as one state; the Maritime provinces of Canada count as one province. British Columbia and the Yukon count as one province.

Snap as many pictures as you want from babies to boys and girls who are beginning to think of themselves as young men and women. Maybe there's a baby right in your own family that could help you win first prize by a big margin. Not necessarily a beautiful child, but one with personality, character, "IT"—in eyes and smile and dimples. Maybe there's such a youngster next door, or next street, but no matter whose baby it is, get the kind of picture that shows it at its best.

Every picture of children that you submit stands a chance of winning the Grand Prize; or any of the 103 prizes in each of four other awards. And even if you don't come in for a share of the prize money you will, at least, have made an attractive picture to add to your collection. With a little patience, however, you can almost surely get a picture good enough to win. A striking close-up of a boy or girl; a group at play; youngsters laughing, sleeping; in every-day clothes, rompers, overalls or fancy costume. Anything goes as long as it is a picture of children, and if it has the least

the Largest Prize Contest in Photographic History

in Cash Awards

Grand Prize $2,500 . . . 11 Prizes of $500 each . . . 11 Prizes of $250 each . . . 125 Prizes of $100 each . . . 1,223 Money Prizes in All . . . for snapshots, time-exposures, enlargements . . . only strictly amateur photographers may compete . . . Every picture-taker has an equal chance to win!

spark of interest in it, don't fail to send it in. What looks to you like a "flop" may look like a "wow" to the judges.

This award gives you 106 chances to win: (1) You can enter the March contest for the best child picture from each state, (2) You can enter the April contest for the best child picture from each state, (3) The pictures that you have entered for the state contest during either of these months and pictures that reach Rochester during May are all eligible for the Grand Prize of $2,500 or for any of the one hundred three prizes in Awards No. 2, No. 3, No. 4, or No. 10.

AWARD NO. 1—Scenics—For the best picture of any city or country outdoor scene . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each. Here's your chance to capitalize your ability to spot an interesting outdoor subject. Landscapes and marines, distant and nearby views, mountains and water, nearby bits of nature composition, travel subjects and street scenes.

AWARD NO. 2—Informal Portraits—Pictures made at from, say two to ten feet distance, for the purpose of showing a person's features . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

AWARD NO. 3—Story-Telling Pictures—For the pictures telling the most interesting story . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

Take a picture in which children, adults or animals do something—anything except looking at the camera. For instance, a puppy pulling at a baby's sleeve; children in any form of play; father proudly exhibiting the new car to a friend. There are any number of opportunities for you to take pictures like these.

AWARD NO. 4—Sport Pictures—For the best pictures of sports and games . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each. It may be skating or coasting or skiing—or baseball, tennis, golf. Hiking, too . . . and boating, archery, polo riding—all serve as opportunities to make prize winning pictures.

AWARD NO. 5—Animal Pictures—For the best pictures of pets, live stock, wild animals, either at large or in zoos . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

AWARD NO. 6—Nature Study Pictures—For the best pictures of flowers, birds, butterflies, leaves, rocks, spiderwebs, any nature subject . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

AWARD NO. 7—Building and Architectural Detail—For the best exteriors of homes, churches, schools, offices, libraries, other buildings, or portions thereof . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

AWARD NO. 8—Interior Pictures—For the best inside views of rooms, corridors, staircases, or other portions of homes or other buildings . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

AWARD NO. 9—Still Life Studies—For the best pictures of art objects, curios, cut flowers, any still-life subjects in artistic arrangement . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

AWARD NO. 10—Unusual Photographs—For the best pictures made at night; pictures of fires, lightning, storms, silhouettes; or any pictures that are unusual either as to topic or as to photographic treatment . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 each and 75 prizes of $5 each.

Special Prizes for Enlargements—$1,350—Any picture is a better picture when enlarged. For the best enlargements from negatives made on or after March 1, 1929 . . . a first prize of $500; a second of $250; a third of $100; 25 prizes of $10 and 50 prizes of $5 each. Your film dealer or photofinisher will be glad to help you choose a picture likely to win. (See Conditions Nos. 2 and 4.)

Each of these big cash prizes will have to be won by somebody . . . why not you! Aim at the big money and you stand an excellent chance of winning it or of coming in for one of the smaller prizes. Don't miss this chance of winning a share of the big prize money. There is always the certainty of being rewarded with some excellent pictures you might otherwise fail to get.

THESE ARE THE JUDGES. Observe how diversified are their interests and how broad are their viewpoints and experience. You must admit that no fairer Board of Judges could be assembled than that represented here:

Madame Galli-Curci, internationally known singer; Miss Ethel Barrymore, leading actress; Howard Chandler Christy, noted artist; Clare Briggs, famous cartoonist; James R. Quirk, publisher, Photoplay magazine; Rudolf Eickemeyer, distinguished photographer, Medalist Royal Photographic Society of Great Britain; Hector Charlesworth, author, critic, editor "Toronto Saturday Night"; Kenneth Wilson Williams, editor "Kodakery" and photographic expert.

For the two Monthly Child Picture Contests, the following will be judges: James R. Quirk, Rudolf Eickemeyer, Kenneth Wilson Williams.

NOW—*read the simple Contest Conditions and get your camera out!*

Kodak Film in the familiar yellow box is dependably uniform.
Reduces the danger of under- or over-exposure.
It gets the picture.

PRIZE CONTEST ENTRY BLANK

Name.....
(*Please Print*)

Street Address.....

Town and State.....

Make of Camera..... Make of Film.....

Enclose this blank with your entry and mail to Prize Contest Office, Eastman Kodak Company, Rochester, N. Y.

Do not place your name on either the front or the back of any picture. Be sure that each entry in the State Child Picture Contest is so designated on the back. 167

Emptying a Washing Machine

Controlling a Bathroom Light— And Hints for Home Owners

ALTHOUGH houses built today usually have a built-in drain in the basement or laundry, older houses frequently lack this convenience, and the laundress has to drain the washing machine into pails, which must be lifted to the laundry tubs or carried to a drain. To avoid this work, the writer has constructed an attachment to replace the faucets; it will both fill and drain the washing machine. The attachment operates much like an injector for a steam boiler.

The materials required are shown in Fig. 1. All the fittings are standard ½-in. pipe fittings until the 45-degree tee is reached, at which point a step up to ¾ in. is required. This is necessary because the 45-degree tee, which houses the nozzle to build up the velocity of the water, must also be of a capacity to carry away the additional water which is being drained. The step-up is accomplished by a reducing bushing, which also acts as a holder for the pressure nozzle.

The pressure nozzle is made of a piece of round brass with a ¼-in. hole drilled clear through. The nozzle is sweated into the reducing bushing and should be of a length sufficient to reach almost to the lower end of the tee. The lower end of the nozzle is tapered to allow maximum space for the incoming water. The two upper valves should be of the compression type, while the lower one must be a gate valve.

To fill the washing machine, the gate valve is closed and one or both of the compression valves are opened. The water then passes through the side outlet of the 45-degree tee and through the hose to the machine. To drain, place the end of the hose in the water, close the gate valve, open the compression valve on the cold water side, and then again open the gate valve. This creates a siphoning effect.

Fig. 2. Extension tape makes it possible for children to turn on and off a bathroom light.

One point must be observed when draining—the gate valve must be kept closed until the hose has filled with water; then, when the gate valve is opened, the water leaves the orifice of the nozzle at high velocity and acts on the column of water retained by the hose, causing it to follow in the same direction.

The rapidity with which the washing machine can be drained in this manner is quite surprising. The writer has drained a forty-gallon tank in six minutes. And no labor is wasted.—R. H. KASPER.

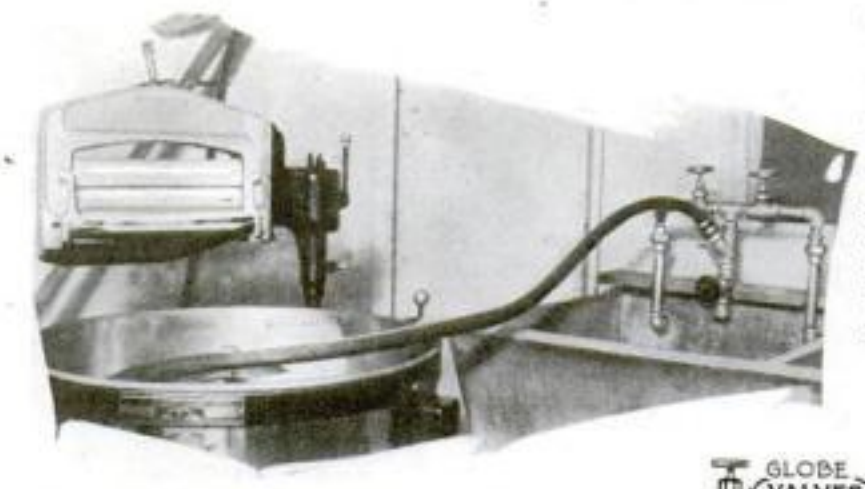
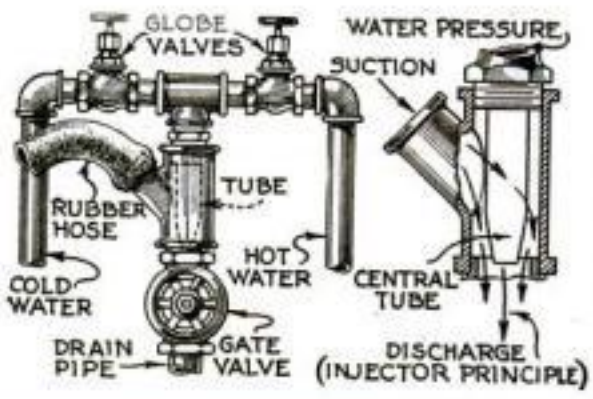


Fig. 1. Attachment for emptying a washing machine. The construction is shown at right.



EASILY accessible to both little folks and adults is the bathroom light switch illustrated in Fig. 2. It is made by attaching a tape to the end of the chain of a chain type socket. The tape is run through a screw eye at the top

(Continued on page 131)

BORN ~ ~ ~ ~ March 1, 1929

of Distinguished Parentage

No. 9 Smooth—Length 9 in. Cutter—2 in. Weight 3½ lbs.

A Complete Line of Planes by Millers Falls

HERE'S a brand-new line of fine planes made by a manufacturer who's been at this business of making fine tools for half a century.

At first glance they look much like the planes you've known. It's after you use them that you note the difference.

Built Around the Cutting Edge

Millers Falls planes are built around just one feature, *the cutting edge.* Our engineers began with steel. Years of experience in selecting and electric-heat-treating of fine tool steels have resulted in refinements that make Millers Falls plane cutters last longer and hold a finer edge.

Other New Features

Next the designers tackled chattering. The precision with which the blade is held at the correct cutting angle, determines how well the plane does its work. So new features were added, such as 3-point bearing of lever cap, making possible hair breadth adjustment that holds and overcomes chatter.

Made for Tool Users

Practical carpenters, cabinet makers, men who love good tools for home shop-work — anyone who uses a plane will delight in the balance, comfortable grip and smooth cutting efficiency of Millers Falls planes. Sizes in bench planes from 7 inches to 24 inches, smooth and corrugated bottoms, and 21 models of block planes, cover every plane need.

Sold by Responsible Dealers

Millers Falls planes will be found in the stores of leading hardware merchants. The mere fact that a dealer offers you Millers Falls is proof that he desires to sell you truly fine tools and so win your permanent patronage and good will.

A new catalog for tool users is ready. Send today for free copy without obligation. It shows a wide variety for your choice in 14 major tool lines.

Ⓢ

MILLERS FALLS CO.

MILLERS FALLS, Massachusetts
NEW YORK: 28 Warren St. CHICAGO: 9 So. Clinton St.

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Turning a Flag into an Egg

Is an Easy Trick with Which to Mystify Your Friends if You Know What Preparations to Make

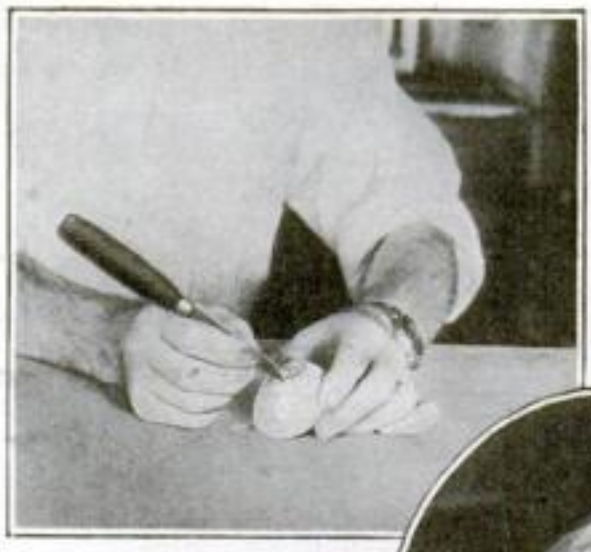
By GEORGE S. GREENE

IN THE flag and the egg trick, which is a most effective one for the amateur magician, a silk flag is stuffed into the cupped hands, yet when the hands are opened nothing is seen but an egg.

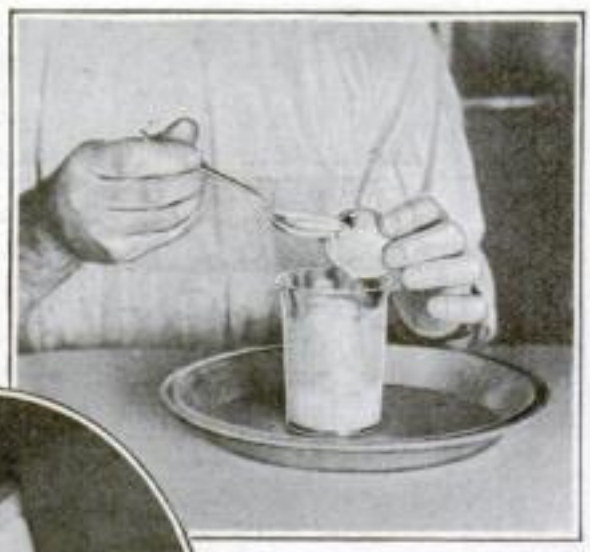
To prepare for the trick, chip a hole the size of a quarter in the side of an egg with a knife and allow the contents to flow out. The remaining egg shell must be handled carefully.

A tablespoon of plaster of Paris is mixed with water until a thin paste is formed, and this poured into the egg. The shell must be kept continually in motion until the plaster sets, so that the entire inside will be coated with a thin layer of the plaster. When the plaster is quite hard, the hole may be trimmed and smoothed up. In this condition the egg may be handled without breaking.

Before the trick is performed, the prepared egg is deposited in the pocket with a silk flag. When the time comes, the egg, covered by the flag, is removed from the pocket. The hands are cupped together around the egg, and the middle fingers are used to stuff the flag slowly into the egg. The latter may then be exhibited as a genuine, unprepared egg, with the fingers held over the hole so that it will not be seen.



A hole the size of a quarter is chipped in one side of the egg, but great care must be taken not to crack the shell.



Plaster is poured into the egg, which is kept continually in motion until a thin, hard lining is formed inside.

How the egg is removed from the pocket under cover of the silk flag.

Stuffing in the flag. In actual performance the hands conceal the egg.

When the egg is revealed and exhibited, two fingers conceal the hole.

Taking Pictures Backwards for Amateur Movies

TO GET reversed motion with an amateur movie camera, merely hold it upside down while taking the particular scene which you want to film backwards. When the roll is returned to you, separate the reversed scene and splice it in, turning it end for end so that it will run right side up in the projection machine.

There are many amusing tricks possible with backward motion. A person dropping from a high wall when taken in this way will appear on the screen to jump from the ground to the top of the wall. Two automobiles photographed as they back rapidly away from each other will appear to collide.—H. N. WHITMORE.

A STRICTLY LOCAL STATION

"FOLKS, this is station F-U-N-N. Before playing our next number we want to tell you we use Eveready Layerbilt 'B' Batteries 'cause they last longer. They've got layers in 'em like a cake. When Mother bakes a cake we eat it right up quick, and it doesn't last at all, but you can't eat an Eveready Layerbilt and a radio set can't eat it up either. That's why it lasts so long. Father says he saves a lot of money by buying Eveready Layerbilts. You will now be entertained by the orchestra of the Great American Music, Social and Athletic Club playing the song, 'That's my battery now.' "

NATIONAL CARBON CO., INC.
New York UCC **San Francisco**
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This is the original Eveready Layerbilt No. 486—the LARGE SIZE for heavy duty — list price, $4.25, only 25 cents more than the Eveready cylindrical cell battery of the same size, No. 770. The other Eveready Layerbilt is the Medium Size No. 485—list price, $2.95, only 20 cents more than the Eveready medium size cylindrical cell "B" battery No. 772.

Layerbilt construction is a patented Eveready feature. Only Eveready makes Layerbilt Batteries.

TUESDAY NIGHT IS EVEREADY HOUR NIGHT

***East of the Rockies*—9 P. M. Eastern Standard Time, through WEAF and associated N. B. C. stations. *On the Pacific Coast*—6 P. M. Pacific Standard Time, through N. B. C. Pacific Coast network.**

SEE AND HEAR THE NEW EVEREADY RADIO SETS

Landing Gear *for* Model Planes

By VINCENT L. JOHNSTONE

IF YOU use the landing gear described in this article with a model built according to the plans in the March issue for the world's record seaplane of Tudor Morris, you will find yourself in a good position to win prizes in any model airplane contest.

What would be better for an R.O.G. (rise-off-ground) contest plane than the 12½-minute Morris model with this landing gear instead of the floats? The extreme light weight and the simplicity of both the construction and the attachment of this gear should make your model the envy of all your friends.

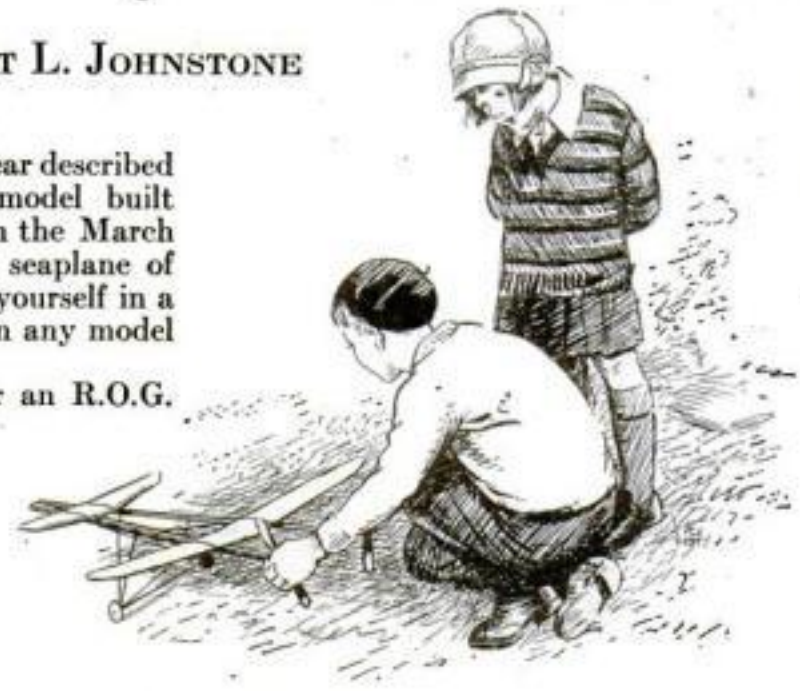


Fig. 1. With landing gear substituted for floats, the Morris world's record seaplane can be used as a rise-off-ground model.

You will need only a few materials: 1 pc. bamboo, 12 in. long, several yards of heavy silk thread (size D buttonhole twist preferred); 1 pc. balsa veneer, $\frac{1}{16}$ by $\frac{3}{4}$ by 1½ in.; 4 washers; 2 common pins; and a small piece of No. 6 (.016 in. dia.) music wire.

This type of front landing gear, which

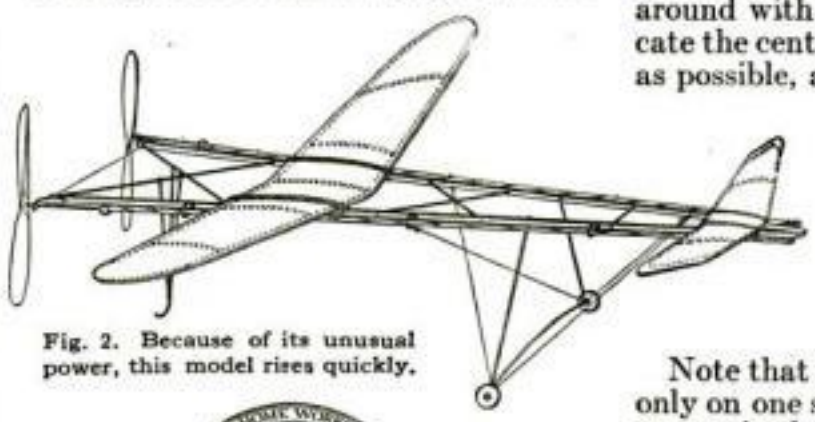


Fig. 2. Because of its unusual power, this model rises quickly.

is shown in Figs. 1, 2, and 3, was used on the machine that holds the world's twin pusher R.O.G. distance record. There is another very good and more recent type illustrated in Fig. 5, but it requires more care in mounting on the A-frame and is given mainly for advanced model makers, to whom the drawings will be self-explanatory.

For the landing gear shown in Fig. 3, you will need to make two pieces of bamboo 10 in. long and $\frac{1}{16}$ by $\frac{5}{64}$ in. in cross section, which should be oval. Then you will need to make the crosspiece, which is bamboo $\frac{1}{32}$ by $\frac{1}{16}$ by 12 in.

Remember that in reducing bamboo to size it is advisable to split the wide stock in the center each time. Even if it is as much as an inch wide, for example, split it in the center; then split one of the ½-in. pieces into two ¼-in. pieces, and so on, until you have obtained the exact size you want or slightly larger. You can easily scrape and sandpaper the piece to the desired shape in cross section.

Use only the part of the bamboo next to the shiny or outer surface of the pole, as this part of the wood is much tougher and can be made considerably smaller and lighter in weight than would be possible if you used the weak and brittle inner part of the pole.

The two wheels are made by holding a small coin—a penny, nickel, or dime—against the balsa veneer and cutting around with a knife or razor blade. Locate the center of the wheels as accurately as possible, and with an ambroid type of cement fasten a washer exactly in the center of one side of each wheel. Allow the cement to dry thoroughly without disturbing it, which is the secret of using this kind of cement successfully.

Note that you should fasten the washer only on one side of the wheel at first. The reason is that it is much easier to make the wheel run true if the first washer is solidly cemented before you locate and fasten the second washer. You can use a common pin as an axle to rotate the wheel while sighting for wobble. By shifting the second washer, it is easy to make the wheel run absolutely true. When the cement on the second washer is dry, you can consider the wheel as done, unless you wish to take some fine sandpaper and slightly round the edge of the rim to streamline it.

To make it (*Continued on page 127*)

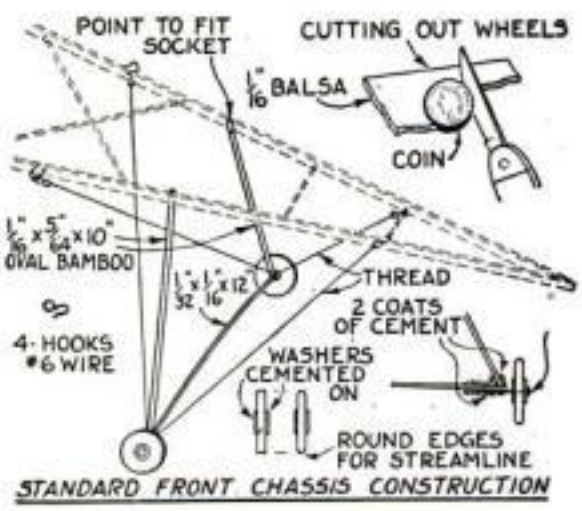
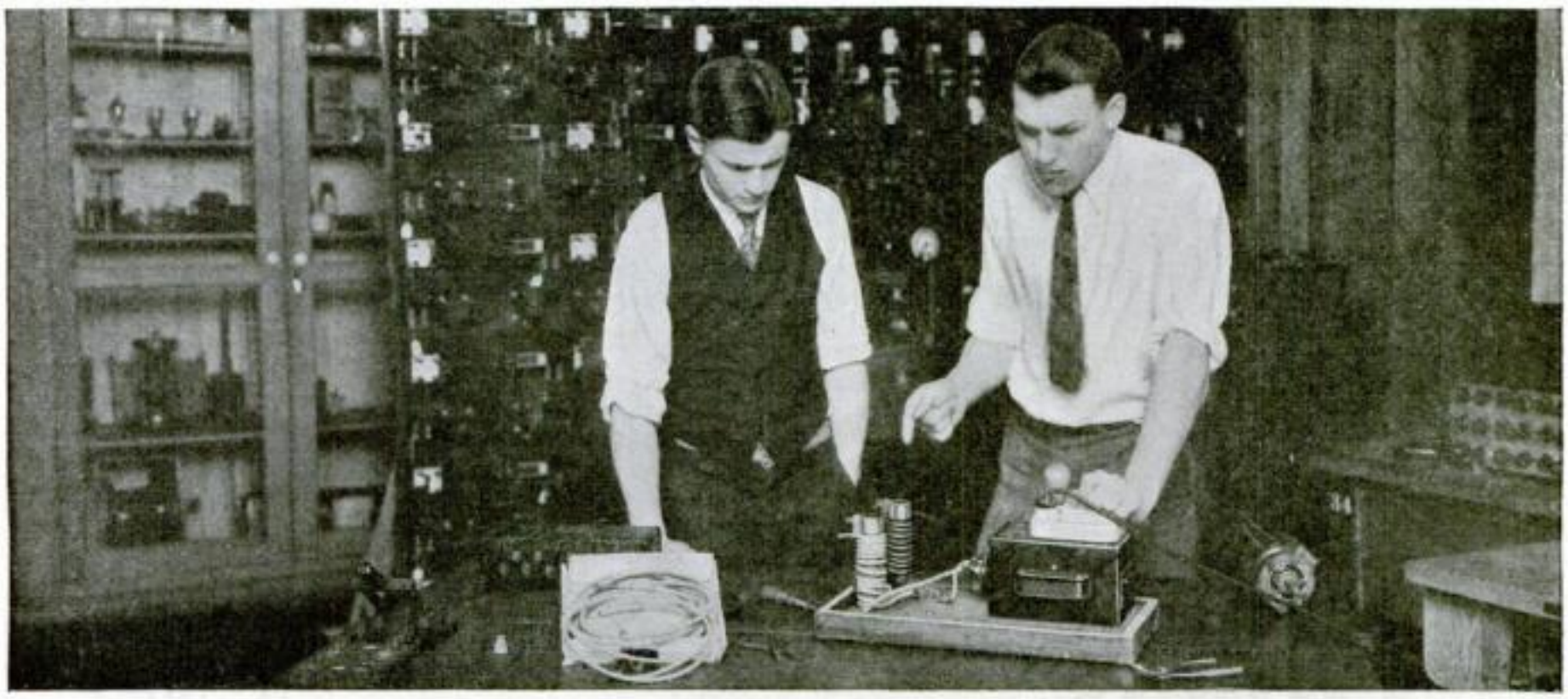


Fig. 3. Details of the front landing gear and how the balsa wood wheels are cut and mounted. Note the use of thread braces.



This Machine Develops Corona Tests for High Tension Cable Used on Modern H. C. Engines

What is Corona?

Corona is an electrical phenomenon present on the outside of all high voltage conductors. It is accompanied by the release of free ozone due to the electro-chemical breaking-down of the surrounding air. Corona can be seen in the dark as a purple glow surrounding the conductor, and can be readily identified by its pungent odor.

How Does Corona Affect Spark Plug Wires?

Ozone is a vital enemy of rubber and causes it to deteriorate rapidly by producing invisible cracks, and eventually opening the insulation through to the copper conductor. The electrical leakage caused by even this slight deterioration seriously affects the power of the motor.

Why is Corona a New Factor?

A few years ago engine compressions ranged from fifty to sixty pounds per cubic inch and required five or six thousand volts for satisfactory ignition. Modern high-speed, high-compression engines require in some instances as high as 18,000 volts for satisfactory ignition, and there are extremely high speeds that render any leakage whatever of vital importance.

How Can Corona Effects Be Minimized?

Although corona is always present in high voltage circuit, its evil effects can be minimized by sealing the rubber insulation against it. This is done in Packard Lac-kard Cable by multiple coats of a special pyroxylin lacquer with which the braided covering is protected. As long as this seal is kept intact, the rubber is protected from the deteriorating effects of the ozone.

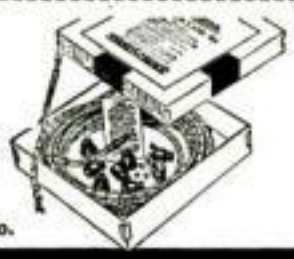
What is Packard Lac-kard Cable?

Packard Lac-kard Cable is the latest development from the research laboratories of The Packard Electric Company. It is rubber-insulated cable of the highest quality, protected by a stout braid which is, in turn, treated with multiple coats of pyroxylin lacquer which hermetically seal the rubber insulation from the attack of ozone. It is the last word in high tension ignition cable.

What are Packard Ignition Cable Sets?

Packard Ignition Cable Sets consist of the different leads from the distributor to the spark plugs and from the coil to the distributor, made up with universal terminals attached to the spark plug end of the cable at the factory. Distributor terminals as well as distributor protectors are included in the handsome purple and yellow carton which is displayed on the shelves of leading automotive dealers and jobbers in the United States and Canada.

SEND FOR STORY OF CORONA, THE POWER THIEF



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OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. Other subjects besides those below are to be had; send a stamped envelope for the complete list.

Popular Science Monthly,
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Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....dollars.....cents

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5.	Kitchen Cabinet	*May, '22	25c
15.	Workshop Bench	*Jan., '23	25c
27.	Kitchen-Cabinet Table	Oct., '23	25c
30.	Tool Cabinet, etc.	*Jan., '24	25c
31.	Sewing Cabinets	Feb., '24	25c
37.	Simplified Bookcase	Dec., '24	25c
43.	Four-Tube Receiver (battery operated)	*July, '25	25c
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71.	Console Cabinet—Details	Nov., '27	25c
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77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan., '28	25c
78.	Simple Treasure Chests	Feb., '28	25c
79.	Electric Radio Set	Feb., '28	25c
80.	High Power Unit for Electric Radio Set	Mar., '28	25c
81.	Low Power Unit for Electric Radio Set	*Apr., '28	25c
82.	Simple Single-Stick Airplane Model (30-in.)	Mar., '28	25c
83-84-85.	*Mayflower* Model	Apr., '28	75c
86.	Racing Airplane Model (35-in. twin-pusher type)	May, '28	25c
87.	Seaplane Model (30-in.)	June, '28	25c
88.	Simple Modernistic Stand; Modernistic Bookcase	Aug., '28	25c
89-90.	*Bremen* Scale Flying Model (3-ft.)	Aug., '28	50c
91.	Modern Folding Screens	Sept., '28	25c
92.	Simple Baltimore Clipper Ship Model (8 in. long)	Sept., '28	25c
93.	Three Modern Lamps	Oct., '28	25c
94-95-96.	Mississippi Steamboat Model	Nov., '28	75c
97.	Modern Electric Radio Set in One-Tube Form	Nov., '28	25c
98.	Modern Electric Radio Set in Two-Tube Form	Dec., '28	25c
99.	Modern Electric Radio Set in Four-Tube Form	Jan., '29	25c
100.	Modernistic Book Ends, Book Shelf, Low Stand	Dec., '28	25c
101.	Toy Fire Engine, Sprinkler, Truck, Tractor	Dec., '28	25c
102.	Morris Seaplane Model	Mar., '29	25c
103.	One-Tube Battery Radio Set (Old No. 41 revised to	Mar., '29)	25c

*Magazine only out of print.

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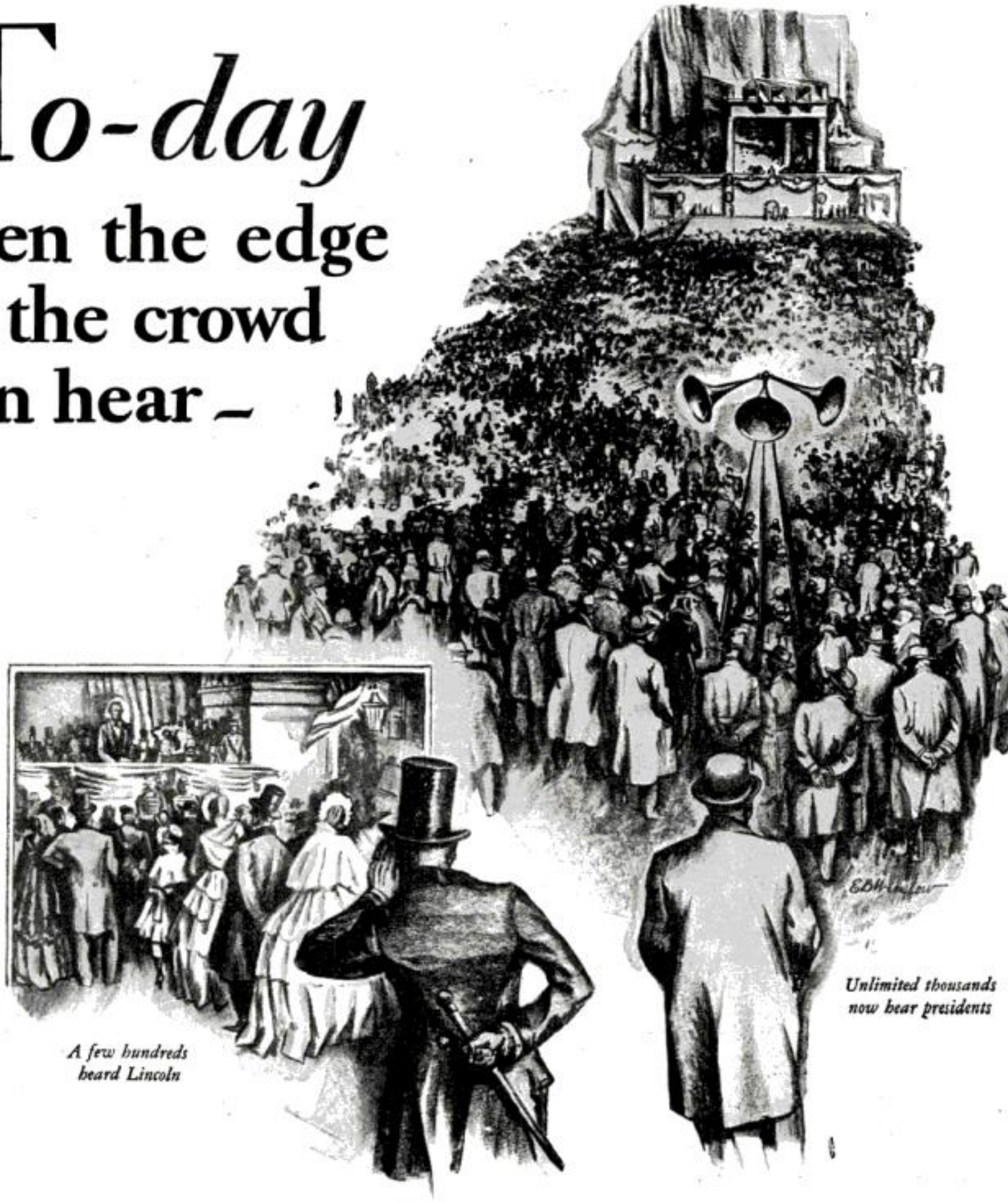
even the edge of the crowd can hear –



A few hundreds heard Lincoln

Unlimited thousands now hear presidents

At present-day inaugurations of Presidents of the United States, everybody in the vast crowd assembled at Washington is able to hear every word of the ceremony. A Western Electric Public Address System, with its loud-speaking horns above the speaker's stand and at strategic points in the crowd, makes this possible.

This apparatus amplifies sound and distributes it to all parts of a city park or square or an indoor auditorium. In convention halls of hotels, it brings the speaker's voice loud and clear to people in the rear seats.

The Public Address System has a growing use in hotels, in amusement parks, in hospitals, where music or other entertainment can thereby be distributed from a single source to any number of places or rooms. The equipment is adapted to a wide range of requirements . . . A product of the telephone art, the Public Address System is electrically and mechanically dependable. It is made by Western Electric and sold by Graybar Electric—two names that mean quality and service in things electrical.

Western Electric

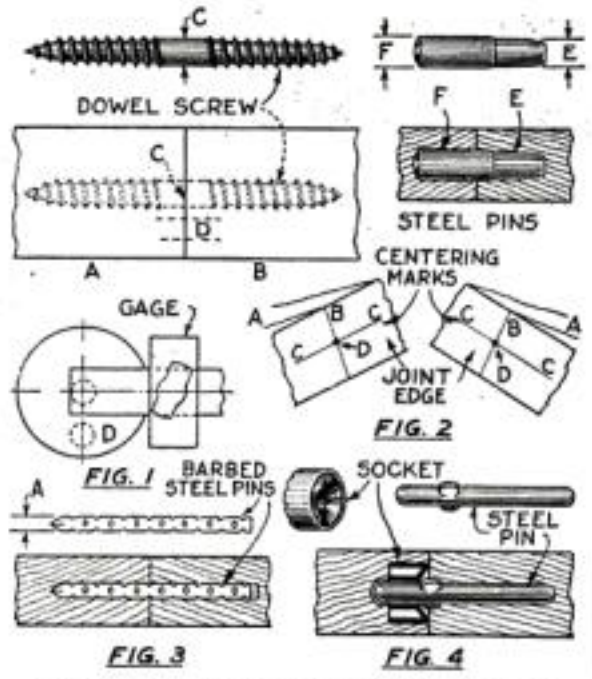
PUBLIC ADDRESS SYSTEMS

Distributed by GRAYBAR *Electric Company*

Metal Fastenings for Woodwork

HARDWOOD dowels may be used in different ways. For some purposes, like reinforcing a glued joint, there is no adequate substitute; but for other purposes there are metal pins and screws that are more efficient than the wood dowel. These may be bought in many ordinary hardware stores or ordered from the catalogue of a large hardware dealer.

The lengthening of a wooden rod by means of a butt joint may be done easily, as shown in Fig. 1, by the use of a dowel screw. The joint is stronger than if a wooden dowel were used. One end of the screw may be turned into piece *A* with pliers, and piece *B* then is turned until the previously fitted ends are in perfect contact. This requires the accurate locating or centering of the dowel, or of the hole *C*, which should be no larger than



Methods of making joints in woodwork with dowel screws and three types of steel pins.

the unthreaded central part of the dowel screw. The holes may be centered by using a gage from four sides of the joint end of each rod as indicated, and marked definitely with a center punch to permit the exact centering of the drill. In certain cases the joint will be stronger if the screw dowel is placed near the edge where the greater tensile strain occurs, as at *D*.

The steel dowel pins in Fig. 2 may be used as a guide in bringing two edges together. Center the holes accurately by placing the pieces together and mark *A*. then *B*, following with gage mark *C* and center punch mark *D*, as indicated. Bore the holes in each piece the size of the smaller end of the pin at *E*, for the pin then will be held by the pressure of the wood at *F*. Drive the pin into *F*, perhaps using glue sparingly, but do not use glue in hole *E* if the joint is to be opened again.

The barbed steel dowel pin in Fig. 3 may be centered by the same method and a hole bored in each piece of a size (*A*) that will allow a close push fit for the dowel. Glue may be used sparingly.

The steel pin and socket in Fig. 4 are especially valuable where pieces of wood are to be repeatedly pushed together and separated.—DAVID WEBSTER.

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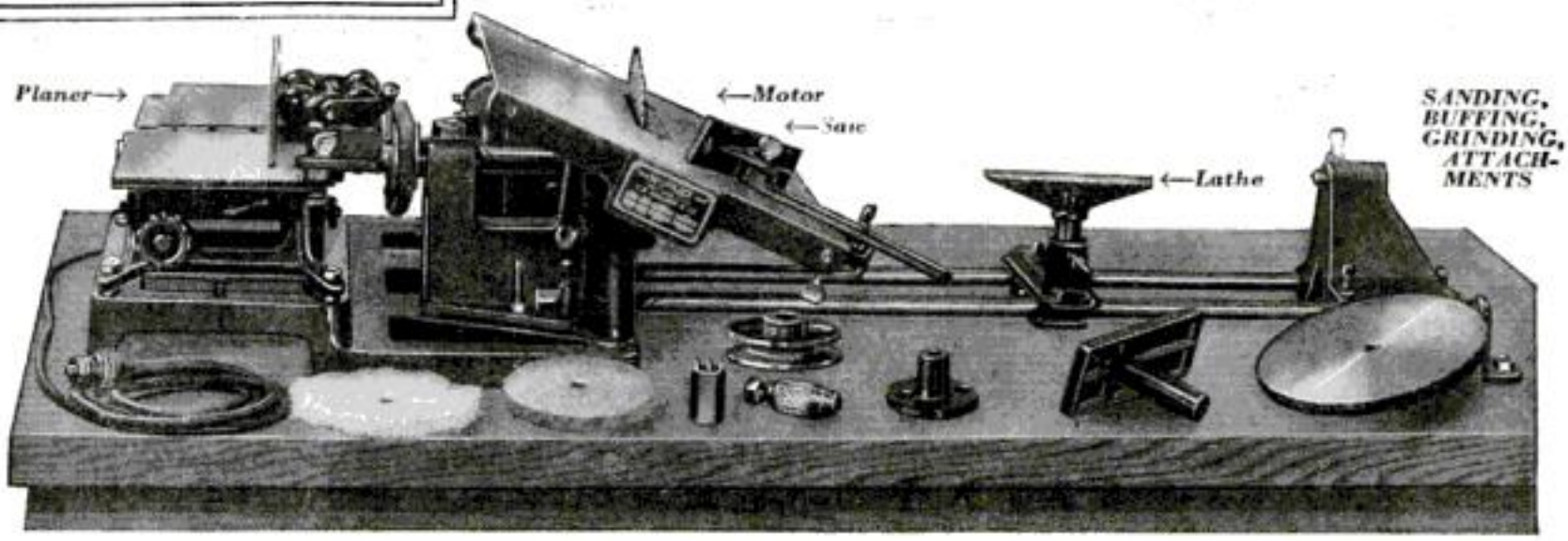

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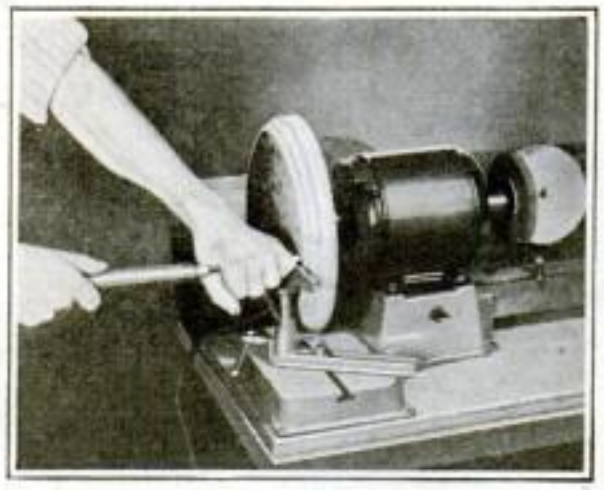
This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Turning Large Work on a Small Lathe

AS THE owner of one of the popular electric workshops with a capacity for turning wood about 9 in. in diameter, I was confronted with the problem of turning a piece to a diameter of 10½ in. I found that I could easily turn this piece or, indeed, one as large as 11 in. by placing the faceplate on the left instead of the right side of the motor.

My workshop has a two-shaft motor of sturdy design so that by taking off the circular saw and attaching the tool support base to the T-slot as shown, I was



Faceplate on left end of a small motorized home workshop for turning a 10½-in. disk.

able to accomplish the job quickly without devising any awkward makeshift arrangement.

One caution should be observed: The stock should be cut a little larger than the finished diameter on the scroll saw before it is fastened to the faceplate, and the faceplate must be fastened to the exact center of the stock. This will prevent excessive vibration and the possibility that the stock might be torn from the faceplate. It is also important that the faceplate be fastened securely with four heavy screws so that there will be no danger of its loosening during the turning operation.—JOSEPH LUKOWITZ.

Novel Way to Bend Bamboo for Model Airplanes

THAT readers in far corners of the world are building POPULAR SCIENCE MONTHLY airplane models is indicated by many letters which have been received, among them the following from J. P. Smith, of Christchurch, New Zealand:

Using an electric iron to soften bamboo.

"Some of your readers, when making model airplanes such as the *Bremen*, may have experienced difficulty in bending bamboo in the exact place required by means of an ordinary candle flame. This difficulty may be easily overcome by using the ordinary domestic electric iron as illustrated. I found that very accurate bends could be made by this method, and had no scorchings or breakages."

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AERONAUTICAL CHAMBER OF COMMERCE

How to Display a Ship Model

If You Have Built Our Mississippi Steamboat, You Can Place It on Pedestals or in a Scenic Case

By E. ARMITAGE MCCANN, *Master Mariner*

Captain McCann painting on canvas a typical river scene against a sunset sky. The landscape was used later as the background in a scenic case.

MANY of the ship model builders who have been following our Mississippi steamboat articles now have their models of the *Buckeye State* completely finished. There remains but the problem of mounting and placing it—a problem of interest to all who make ship models.

The first thing to be considered is: Where is it to be kept so that it will appear to the best advantage and yet not be in the way?

In a very small house there may not be a vacant table, stand, or mantelshelf on which to place it. In this case I suggest fastening a shelf to the wall and standing the model on short pedestals, as illustrated in one of the photographs on this page, unless one can find a suitable niche or angle in the wall for a shelf to support a scenic case. Small as our model is, a scenic case, being somewhat large, would look clumsy projecting from a flat wall. If, however, the room is large enough to house a scenic case without its being obtrusive, the most picturesque method of mounting this type of model is to place it in one so that the model will appear as if in her everyday surroundings, steaming up the Mississippi or Ohio River.

The first thing to do is to make the case itself. I made mine 9 in. wide, 14 in. high, and 30 in. long. A wider and longer case would be better if there is sufficient space for it.

The original *Buckeye State* model displayed in a scenic case.

Another way to mount the model is on a pair of turned pedestals like the one shown above.

Any well-seasoned hardwood or softwood will serve. If a substantial piece, say ⅞ in. thick, is used for the bottom piece, the rest can be very thin. A piece of fiber wall board will do for the back.

For the water I obtained a piece of rippled green glass, 8¾ by 30 in., and cut a hole in it to re- (Continued on page 120)

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

MOST of us at some time or another have picked up bargains in "all wool" men's suits or other garments at absurdly low prices. Later we have sometimes realized that the money had been thrown away through our inability to distinguish between the common textile fibers. The average buyer of bargains in this line makes no test of the fabrics, but the expert buyer for a wholesale house will take nothing until the goods have been subjected to a rigid scientific analysis in a chemical laboratory, by means of which the percentage of cotton or other adulteration can be discovered.

Under the tester's microscope and reagents, cotton stands forth from wool, and the number of cotton threads in such a mixture can be counted. Some of these standard tests are simple enough for the amateur to perform in his own home laboratory. If a finished piece of goods is to be analyzed, small bits for the work can be cut from such places as the inside of the seams without damage.

The burning test should be applied first. To do this, pull out an individual yarn or thread and hold in the flame of a match until it ignites. Wool catches fire with difficulty and burns with the characteristic odor of burning hair. Cotton and linen, upon the other hand, ignite readily and burn with little odor. Since certain mixtures contain one wool yarn alternating with one or more cotton threads, this test should be applied to several fibers in both warp and woof.

THE boiling lye test is more troublesome but is the classic method for detecting, and determining the amount of, an adulteration of wool. It should be tried by the amateur following his match experiment. The method is to count the number of yarns or threads in a small square of the cloth and then immerse it for exactly ten minutes in a gently boiling, five percent lye solution. If the tester lacks a balance for making up this solution by weight, he can make one of approximately the right strength by dissolving one teaspoonful of strong lye in twenty teaspoonfuls of water.

At the end of ten minutes, what is left of the square of cloth is removed from the solution, washed, and the remaining threads are counted. The woolen yarns in the mixture will have been entirely dissolved, while cotton or linen threads will be uninjured. Wool is the only common textile fiber dissolved by this treatment, so the analyst cannot go wrong. The quotient obtained by dividing the number of remaining threads by the original count, multiplied by one hundred, gives the percentage of threads other than wool used in adulterating the mixture.—W. H. HAMMOND.

Mixing a Low-Cost Varnish Remover

By R. C. STANLEY

IN THE first of my series of articles on repairing antique furniture, which began in the December, 1927, issue, I gave a formula for making varnish remover. Since that time I have done some experimenting and wish to give readers the benefit of the results in the form of a recipe which modifies the previous one and reduces the cost considerably.

Mix (cold) 1½ pts. acetone, 2½ pts. benzol, 4 pts. denatured alcohol, and 2 oz. paraffin wax shaved fine. All these liquids boil at a lower temperature than does water. Bring to a boil a sufficient quantity of water and remove it from the vicinity of the fire. Place in it the vessel containing the mixed ingredients. In a short time the shaved wax will melt.

The wax is used to give a body to the remover, so it will stay where it is brushed on and will not evaporate too quickly. If the remover is placed in hot water a few minutes before starting to use it, the wax will melt; using the remover warm enough to keep the wax in liquid state gives a quicker and more thorough action. These ingredients evaporate very rapidly when hot, so should be kept covered when possible.

A PREVIOUS article mentioned several uses for vinegar. Here are others: Paint and varnish brushes which have become dry and stiff can be made pliable again by soaking them bristle deep in vinegar heated almost to the boiling point. A strong solution of vinegar and salt will remove nearly all stains, grease, and spots from wood. The same solution may be used to give brass, copper, and iron a tarnish, which, if protected by lacquer, will make a beautiful antique finish. Simply immerse the metal in the solution until it takes on the desired color.

When repairing broken china, glass, pottery, or crockery, wash the edges thoroughly with hot vinegar before gluing or cementing them together.

If aluminum or galvanized metals are to be painted, first wash them with vinegar, just as you might wash painted woodwork with water. The paint will not scale from the metal as it is apt to do when no precautions are taken.

The vinegar, being an acid which is noninflammable and nonexplosive, is not dangerous to use. When a mild acid is required, it can be tried and if the desired result is not obtained, no harm has been done, as would be the case with many other acids.

These are the concluding suggestions of Mr. Stanley. In his series on repairing old furniture he has placed at the disposal of POPULAR SCIENCE MONTHLY readers the information gained in a lifetime's experience in repairing and refinishing furniture. For readers who have missed any of the articles and may wish to refer to them, the complete list is as follows: December, 1927; April, July, August, October, November, 1928; and January and February, 1929.

A definite program for getting ahead financially will be found on page four of this issue.

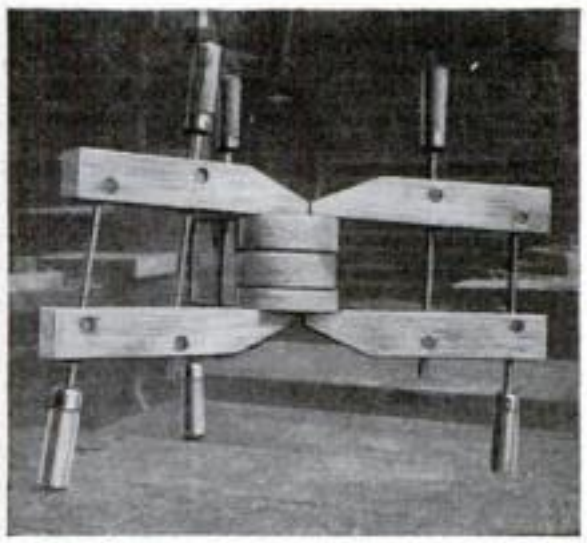
Turning Boxes and Bowls

(Continued from page 80)

a layer of light colored wood 1 5/16 in. thick.

If these layers can be had in the thicknesses required, they may be glued up in one solid block as shown in the photograph on this page. The block is then prepared and turned in the usual manner. If this is not possible, the following slower method is recommended: The lower part of the box may be built up by gluing a piece of dark wood to the waste stock as explained above. When the glue is dry, it is turned down to 3/8 in. in thickness and made perfectly level and flat. The next layer of light wood is glued in place and faced off, followed by the dark layer and then the final light layer. When the required layers, reduced to the proper thicknesses, have been glued together in this way, the stock is ready to be turned. The cover for the box is built up in the same manner. The first layer of light wood is 2 in. thick and is screwed directly to a faceplate. This is faced off and followed by a dark layer, this in turn by a light layer, and this by a dark layer.

As the cover must be of exactly the same diameter as the lower part of the box, these two



How layers of woods of different colors are glued together for making an inlaid box.

parts are put together as shown in Fig. 5, smoothed, and sanded. The dead center is run into that part of the cover from which the knob is turned. This adds to the stability of the box during the final smoothing and sanding.

The knob is the last part of the box to be turned. This is easily done while the whole box is mounted between centers as shown in Fig. 5. Enough material should be left on the knob when the cover is cut off so that the mark made by the dead center may be entirely cut away.

In all inlay work it is well to remember not to have too violent a contrast between the inlay and the inlaid surface. If, for example, imitation ebony (ebonized wood) and maple are used for the jewel box, the maple should be stained a darker color such as amber, which resembles antique maple.

After completing the trays and boxes, the woodworker who has followed this series of articles should be able to analyze and determine for himself the best way to do any ordinary job in spindle and faceplate turning.

The nut bowl, Fig. 6, is turned by the "glue-to-waste-stock" method as explained last month. The design may be modified so that a small circular block is left in the center similar to the one shown in Fig. 3 on page 81 of the March issue. In this case, however, the block is not removed. Instead, small holes are bored in it for receiving the nut picks when not in use.

The fruit dish, Fig. 7, consists of two parts. The base is turned between centers in the usual way. The top may be turned in the way the covers of the boxes were turned (see Fig. 4). It has to be chucked so that a hole may be bored in its underside for the 3/8 by 1 1/2 in. tenon on the base. In gluing the parts, leave the upper part in the chuck and center the lower part by running up the dead center.

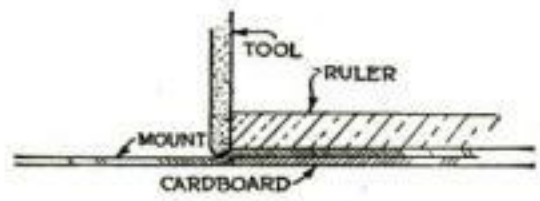
Dressing Up Photographs

(Continued from page 92)

mid-point between the right edge and the point *B*, and make another dot at *D*. Find the mid-point between *B* and the lower edge, marked *E*. With a soft pencil draw very lightly the lines *EF*, *DG*, and *FHC*. The point *H* determines the position for the lower right-hand corner of the print.

"After you have used this system a few times," Jack went on, "you can quickly find the position of the print by making light dots without drawing lines which must later be erased.

"The panel comes next," he continued. "After fixing the final position of the print by making a fine pinhole at each corner, turn the mount over and draw lines on the back in such a way that a rectangle is formed larger than the space marked off by the pinholes by about ¾ in. on the top and sides and 1 in. on the bottom. With a wet rag moisten the paper along one line. Then lay under the mount a piece of thin cardboard with a perfectly straight edge, so that the edge coincides with the line, the cardboard being inside the rectangle. [See one of the accompanying photographs.] Lay a ruler along the line and trace one side of the



How the embossing is done by tooling the mount down over a strip of thin cardboard.

panel with a blunt instrument, such as a buttonhook or the handle-end of a crochet hook. Stop exactly at the intersecting lines. This treatment will bend the moist paper slightly over the edge of the cardboard. When this has been done for every line, a neat panel will have resulted. The depth of the panel is governed by the thickness of the cardboard.

"NOW turn the mount over again. You can provide a thin black border about the print by using an 'underlay'—a piece of black paper cut slightly larger than the print so as to form a band about an eighth inch wide all around. The print is fastened to the underlay and the underlay is attached to the large mount by means of a little high-grade paste or glue at each of the corners. Often only the two upper corners need be fastened, as the glass will hold the others in place. Instead of glue, you can use a good self-curing rubber cement painted over the entire back. This has the advantage of producing a perfectly flat mount without staining the print."

"What kind of frame is the best?" Henry asked.

"That depends largely on your personal taste, as well as the color of the picture. I like a dark, even a black, frame for some prints; others look better in a light one. Some people prefer to have the color of the frame match the predominating color of the picture. Probably the picture of Mary Ellen would look better in a delicate polychrome.

"Now, just because I have described one combination of picture, underlay, mount, and frame is no reason why you cannot work out other pleasing schemes," Jack added. "In fact, if you have a number of pictures to frame, a slight variety is best. Some pictures may be mounted without an underlay, or with one tinted buff, blue, or some other color."

Henry's first picture mounted according to Jack's suggestions was declared a success by Mrs. Webster. Within a few weeks many of the attractive prints that had been lying in odd corners of the house had been tastefully framed and were doing duty as interesting decorations for the walls.

Modern Sewing Table

(Continued from page 78)

experience to have this groove cut in the pieces and also to have the faces of them jointed (planed true) at a mill.

About six hand screws are needed to glue up this column properly. When the glue is dry, plane the column square; then lay out the octagonal shape on each end, draw corresponding lines the length of the column, and plane off the corners to these lines.

The base is built up of six pieces. Each is first squared, after which pieces *K*, *L*, and *M* are planed to form further octagons. These three pieces are nailed and glued together, forming one solid piece. The remaining pieces *N*, *O*, and *P* are rounded at the corners and nailed and glued together.

Materials for Sewing Table

Mk.	Part	No. Pcs.	T.	W.	L.
A	Sides of box	2	5/8	8	17 1/4
B	Sides of box	2	5/8	8	12 1/4
C	Bottom of box	1	3/4	13 1/2	17 1/4
D	Cleats at top of box	2	3/8	5/8	18
E	Cleats at top of box	2	3/8	5/8	13 1/2
F	Slats for sides of box	4	3/8	3/4	7 3/8
G	Slats for sides of box	60	3/8	1	7 3/8
H	Top	1	3/4	14 3/4	18 1/2
I	Top	1	1/4	14 1/4	18
J	Column	2	2	4	15
K	Base	1	3/8	4 3/4	4 3/4
L	Base	1	1/4	5	5
M	Base	1	1 1/8	9	9
N	Base	1	3/8	11	11
O	Base	1	1/4	10 1/2	10 1/2
P	Base	1	1	11	11
Q	Feet	4	5/8	1 1/2	1 1/2
R	Sides of tray	2	1/4	2 1/4	15 3/4
S	Sides of tray	2	1/4	2 1/4	6 3/4
T	Partition for tray	1	1/4	2 1/4	15 1/4
U	Partition for tray	4	1/4	2 1/4	3 1/4
V	Bottom for tray	1	1/4	7 1/4	15 3/4
W	Cleats for tray	2	5/8	3/4	12 1/4
	Iron bolt	1	1/2		19
	Flathead screws (No. 9)	24			1 1/4
	Butt hinges, brass	2		2	2

All dimensions are in inches.

The base is bolted securely together after short dowels have been placed between the upper and lower base, the upper base and column, and the column and the box to keep these pieces in their proper position and prevent them from turning when the bolt is tightened.

A 5/8-in. hole is bored through the center of the bases, and a larger hole must be made in the underside for a washer and nut. The four feet are glued and screwed to the underside of the lower base. The box, column, and bases then may be bolted securely together after

For the tray, which is simply glued and nailed together, 1/4-in. plywood is suitable. The tray rests and slides from side to side on two cleats screwed to the inside of the box. The top is made of two pieces, glued one on top of the other, but it may be of one solid piece or of 5-ply stock, either 3/4 or 7/8 in. thick. The plywood is least likely to warp, but the edges must be left square and either veneered or painted. The top is hinged to the rear edges of the box. If so desired, a small lock may be set into the front edge of the box.

Preceding articles in this series described a stand and a bookcase (August, 1928), several modernistic screens (September, 1928), three modernistic lamps (October, 1928), skyscraper book ends, a modernistic bookshelf, and a low stand (December, 1928), and a cabinet (January, 1929). For blueprints see Nos. 88, 91, 93, and 100, page 108.

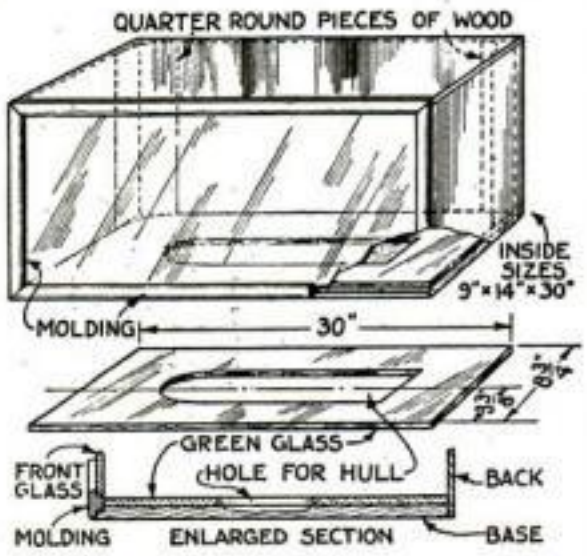
Displaying a Ship Model

(Continued from page 114)

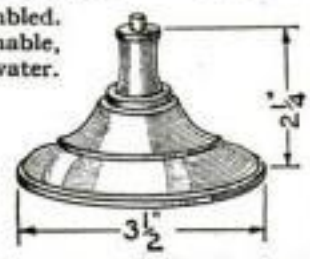
ceive the hull up to the water line, including the rudders and paddle wheel. The center line of this hole should be 1 or 2 in. nearer the front than the back of the glass and about the same amount forward of the middle.

To cut the opening accurately is a tricky job and requires patience. After cutting the outline, one has to start in the middle with short cuts, break out a small hole, and then cut and break off the rest, a small piece at a time. One can, however, get it ground out if a glass company with the necessary equipment can be found.

The glass is set in the case so that it slopes slightly to the front and its front edge will be barely below the edge of the molding that is to be placed on the front of the case. Dig out



How the case is assembled. Rippled glass, if obtainable, is used to represent water.



The pedestals can be turned in various designs or made by cutting down old turnings.

the baseboard, if necessary, to admit the hull to the right depth, so that the top of the glass will be at the water line. Streak the wood under the glass with yellow and brown paint to give the appearance of flowing and slightly muddy water.

When the model is set in the glass, some lightly tinted cotton wool placed between it and the glass and about and behind the paddle wheel will give an appearance of foam and hide the joint.

If the glass is not obtainable, a somewhat similar effect can be had by carving the wood to a slight ripple (there would be no big waves) and then painting it to represent river water.

What color is river water? Well, the muddy Mississippi River can appear to be almost any color. If you look down into it, the color may be brown-yellow; if you look along it, with a blue sky above, it will be blue; or if you look, as one usually does, partly down and partly along the water, then it will be a green with more or less yellow in it according to the angle and the depth of the water. At sunset it may be gold or red. Take your choice.

Next comes the background. This is best painted on prepared canvas with artists' oil colors. When the paint is dry, glue the canvas firmly to a sheet of cardboard and then set it in the case so as to stretch across the back and come to the front of the case at the sides. A few small tacks along the edges will hold the canvas in position. Note that the rear corners of the case are first filled with half-round blocks of wood.

If water colors are preferred, the same scene can be painted with them on Bristol board or drawing paper.

As for the scene to act as a background, anything that looks (Continued on page 121)

Displaying a Ship Model

(Continued from page 120)

like the bank of the Mississippi or Ohio River will serve. If one has but little skill with paints, an earth bank (levee) with blue sky above will be quite typical of the lower reaches; but if one can handle paints, a more elaborate piece of scenery will be attractive. My background is reasonably typical of the lower Ohio with a sunset sky above.

The background should extend to the front of the case at the sides in one continuous view. Join the background to the water with some gesso or putty painted to represent the river bank. The sky should be continued on the underside of the top. One could paint the scene on the back of the case itself, but the other plan is, in the end, easier and more effective.

THE front of the case will need a glass. For this picture-frame or similar molding with a double rabbet is required (see the cross section on page 120). The inner rabbet is for the glass and the outer to set into the edges of the case. Cut the molding so that when the corners are mitered together, the outside edges of the resulting frame will coincide with the outside edges of the case.

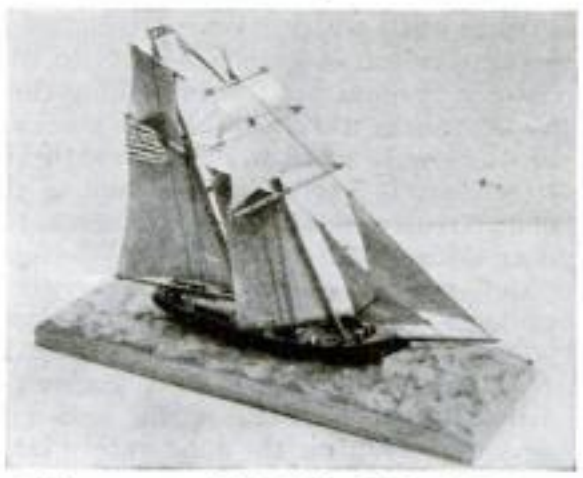
Fix in the glass, set the frame on the case, and keep it in position with some side hooks or a few small screws driven from the sides. Varnish, paint, or lacquer the outside.

In the alternative method of mounting the model, short pedestals can be turned or, perhaps, cut from some old furniture turnings. They should have short dowels in their upper ends to enter holes in the hull. These supports do not have to be any particular size, shape, or color, but the less conspicuous they are, the better. Mine are antiqued gold.

The chief object of the pedestals is to lift the model clear of what it stands on, so that one can see the whole vessel even over the edge of a shelf that is high enough to keep the model out of harm's way.

Now I must leave you. If you have had as much joy in making your model as I did from mine, you have had a great deal; and now you have something interesting to look at and very much worth while.

Small Baltimore Clipper Model Is Easy to Make



Picturesque model built by Richard Heinze, of Brooklyn, N. Y., from Blueprint No. 92.

SIMPLEST of all POPULAR SCIENCE MONTHLY ship models to make is the rakish little Baltimore clipper illustrated above. The hull is 5½ in. long and the entire model, including the base, is only 8 in., yet it makes a striking ornament on any desk, table, or mantelshelf. Full size drawings of the tiny ship, the sails of which are whittled from wood, are contained in our Blueprint No. 92 (see page 108). Ranking next to this model in simplicity are the pirate galley (Nos. 44 and 45) and the Viking ship (Nos. 61 and 62).

A good paint spraying **outfit makes a pleasure of painting even wicker pieces.**

How to Do Decorating *with* Paint Spray Guns

By F. N. VANDERWALKER

MANY handy men and amateur painters and decorators are asking just how much of the painting and decorating about the house and workshop can be done with spray guns of the hand pump, foot pump, or small motor-operated types. They wish to know also what methods are required and if really first-class finishing can be done with this new tool.

Perhaps answers to these questions by one who has done finishing with most of these tools of various types, as well as with the larger outfits employed by professional finishers on furniture and automobiles, will be helpful.

In the first place, it should be remembered that the spray gun is a tool and, like any other tool, calls for a certain amount of practice and knowledge of its use before the best results can be gained. There is more to it than putting in the material and starting the machine. It is not an automatic machine. To learn its effective use, however, is not difficult.

The first step is to study carefully the manufacturer's directions. Take it for granted that the manufacturers know more about their products than anyone else.

The smaller types of spray guns operated with air by hand or foot or by a small motor are capable of doing good work with sufficient speed on the surfaces for which they are designed—furniture, wicker chairs, radiators in homes, and all small articles such as picture frames. They are also useful for touching up automobiles. With these guns difficult work, such as finishing radiators and wicker furniture, can be done in a fraction of the time required by the most rapid brushing.

After some experience, perfectly smooth finishes can be obtained with these tools on furniture and cabinetwork with lacquer, paint, enamel, or varnish. The size of the round or flat spray projected by such small spray guns is, however, too small to make them practically useful on large surfaces or for painting houses and barns.

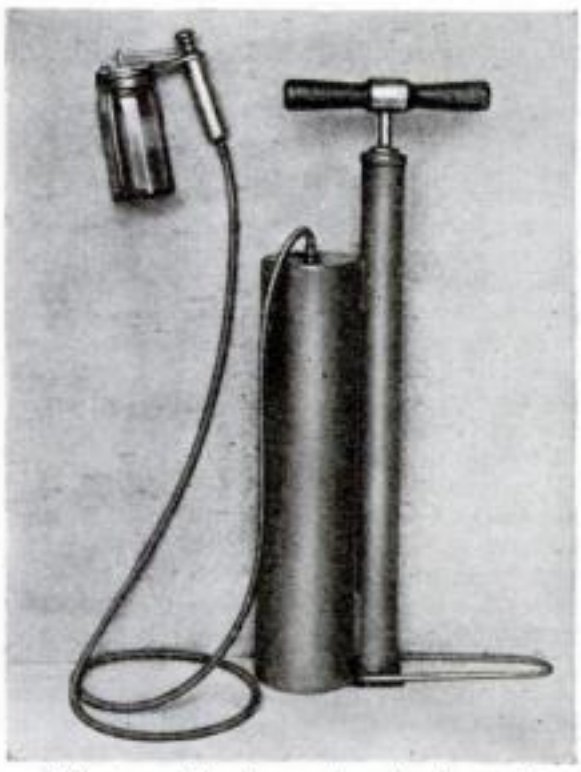
One finds many odd uses for sprayers. For instance, when removing kalsomine or wall paper it helps greatly to spray the surfaces with water. When it comes to the application of glue size coats to wall paper in preparation for varnishing them to make them waterproof, these guns are superior to the brush because with the latter there is a tendency for some of the colors to run under the brush, whereas the spray does not affect the colors. Varnish or lacquer coats on wall paper also can be applied with the small spray guns, especially in bathrooms and halls where the areas are not large. Shingle stains are easily applied with these guns and with fair speed even on the moderately large surfaces of garages and small houses.

IN OPERATING a sprayer successfully it is necessary to consider the material to be sprayed; that is, taking it for granted that the surface has been made clean and fit to receive the finish.

The mixing of the material is very important. The color pigments of lacquer, enamel, and paint settle to the bottom of the can, and unless they are completely mixed into the liquid, the color will not be correct, the opaqueness or ability of the coating to (Continued on page 123)

Decorating with Sprayers

(Continued from page 122)



This type of foot pump is a development of the familiar, useful hand spray gun.

hide the surface will be less than you expect, and the material is sure to clog up the small portholes in the gun, making it necessary to clean them frequently. Therefore, pour most of the liquid off the lacquer, enamel, or paint, and break up the pigment thoroughly. Then add the liquid to it a little at a time as you mix.

When you think the mixing is done, strain the material through cheesecloth tied over the top of a can, and you are likely to find some skins, grit, or lumps of pigment on the cloth. This straining also helps to mix the material better.

Thick liquids like lacquer, enamel, and paint are more easily handled by the spray gun if thinned from ten to twenty-five percent with the proper thinning liquid. For lacquers, use only the special thinner provided for use with the same brand. For enamels, use turpentine; for varnishes, a very little turpentine; for shellac, alcohol. As a rule it is not necessary to thin stains at all.

Thin liquids atomize more easily and with less air pressure than thick liquids. Thin coats dry more quickly; and while they do not hide the surface so well, more coats can be put on in less time because of the rapid drying of each coat. Thick lacquers are apt to run or sag, and thick paints are slow to dry. It is much better to apply two or three thin coats evenly distributed than to try to hide the surface in one thick coat.

Handling the spray gun is the next consideration. Load the material cup on any siphon-feed style of gun (such as the hand pump, foot pump, and small motor types) only about two thirds full. Hold the gun as far as practical in a horizontal position and always exactly at right angles to the surface. Take particular care not to tip the gun to one side or the other and never turn it upside down.

WORK the pump or turn on the motor while holding the gun facing some surface of no account in order to try out the adjustment of the nozzle. Go at it cautiously at first and turn the nozzle-adjusting screw until a solid stream of material comes out. Then turn it in the opposite direction until the material is atomized and comes out in a solid, uniform spray, not in spatters. Having obtained this adjustment, set the nozzle in that position by backing up the locknut or using whatever device is provided on the gun to hold the adjustment constant.

You are now (Continued on page 124)

Decorating with Sprayers

(*Continued from page 123*)

ready to begin spraying. Keep the gun about ten inches from the surface, but never hold it still in one place. Once you start spraying, the gun must be kept moving at a slow and steady pace.

Spraying, like brushing, is done by a sweeping movement. If you stop the movement for an instant while the spray is being projected, you are apt to flood the surface with paint, lacquer, or whatever you are using; and then a run will occur at that point. In that event, have handy a camel's-hair or soft badger brush, one or two inches wide, and use it to smooth over the run. In the case of lacquer it may be necessary to dip the brush in lacquer thinner to dissolve the lacquer run long enough to let you smooth it out.

If runs or spatters cannot be avoided by the adjustment you have, alter it. Possibly, too, you have on the gun a nozzle that is too large. Most guns are furnished with two or more nozzles having holes of different sizes. The larger holes are for thick, heavy liquids; the smaller, for the thinner liquids.

Until you are experienced, it is well to turn the surface down to a horizontal position as soon as you have finished coating it, especially with lacquer. Then, even if you have applied too much in one or two places, it will not run. The rule is to apply a thin coat, evenly distributed over the whole surface, and let it dry before the next coat is applied. It is better to use two or more thin coats than one thick coat. Thus you avoid runs, and the drying is faster.

If you want to spray part of a surface and not all of it, mask the part not to be sprayed with wrapping paper, adhesive tape, or the gummed tape used in shipping departments. There is also a special masking tape made for this purpose. Parts not to be coated also may be protected by a coating of vaseline or other grease, but you must be very careful not to get grease on the part to be finished or the lacquer, enamel, varnish, or paint will not stick.

Having finished a job, pour the material out of the gun and put clear thinner into it and shoot it through to clean the screen and the small tube and nozzle of the gun. Empty it again and put clean thinner in a second time to make sure of leaving a clean tool for the next job.

This is the second of two articles on spray guns by Mr. Vanderwalker, who is a leading authority in the painting trade and the author of several standard books on painting and decorating. The first article, which appeared in the February issue, was on choosing a paint sprayer.

Paraffin Seals Paint Cans

PAINT, putty, furnace cement, and similar materials cannot be kept in open cans without hardening on the surface or deteriorating. To preserve them from one job to another, I protect them from the air with a layer of paraffin wax.

In the case of ordinary paint, I place the can or bucket on a piece of newspaper, mark around it with pencil, and cut out a circle of paper, which is then placed on top of the paint to keep the hot paraffin from running into the paint. Then I pour in melted wax to form a layer ¼ in. thick. Paste, white lead, putty, and cement require no paper; the wax is poured directly on top of them.

The wax, which can be used over and over again, is kept in an old paint bucket ready to be melted when needed. Great care must be taken that it does not catch fire while being melted.—JOHN R. DODGE.

More Closet Space

(Continued from page 86)

up by placing it in a notch, which is cut in a ¾ by 1 by 4 in. block *B*, screwed to the rail on the opposite side of the closet.

Hooks may be placed near the top edge of the head casing on the inside of a closet door as shown in Fig. 4. This is a handy place for hanging hats. It is especially useful in a downstairs closet for the men to hang their hats as they come in. Since this space is out of view, common nails will serve instead of hooks.

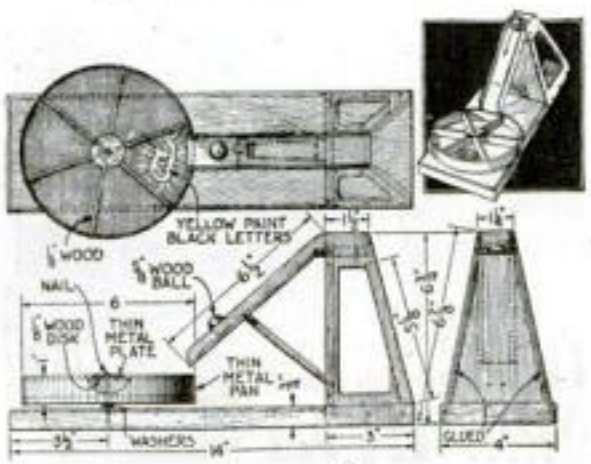
ONE place in closets that is usually idle is the inside surface of the door. This space may be put to use by making a trousers rack as shown in Fig. 3 and fastening it to the cross rails of the door. The rack consists of a piece of wood ⅞ by 3 by 16 in. for the main piece, five pieces of ½-in. doweling 24 in. long, and two pieces of wood ½ by ⅞ by 4 in. The ½-in. dowel rods are placed through the main member so that the upper one is ½ in. from the top end and front edge, and the lower one ½ in. from the lower end and 2 in. from the front edge. The other three dowel rods are placed on a line between the upper and lower ones.

The rack is fastened to the door by the use of two blocks, one at each end at the back. A 1½-in. flathead wood screw is used to secure each block to the rack, but 1-in. roundhead screws are used to fasten the blocks to the door.

The trousers are folded once and slipped onto the rods. Ten pairs may be hung at one time. As the bottom rod is near the back of the main member and each one above is a trifle nearer the front, each pair of trousers hangs nearly plumb. It adds to the neat appearance of the rack if it is made of the same material and finished in the same way as the door.

The inside of a closet door also may be used for a rack for neckties. A suggestion for making such a rack is shown in Fig. 5. It consists of two blocks ¾ by 1½ by 4 in., shaped as shown. A piece of hardwood ¼ by ¾ by 16 in. is fastened to the two main blocks with ¾-in. roundhead wood screws, and the rack is attached to the rail of the door with 1-in. screws.

You Must "Strike Gold" to Win This Game



Top, side, and end views and a sketch of the game in use. It should be painted brightly.

IN THIS new game of prospector's luck, the player puts the ball on the upper platform, spins the pan with one finger at a moderate speed, and pushes the ball into the chute. If the ball falls into the space marked "gold," it is a "strike," and the player retires from the game a winner. If the ball rolls into any of the other spaces, it is not a "strike," and the player waits his turn to try again.

The game continues until one player is left. He is allowed three final chances. If he strikes gold with one of these shots, he is as lucky as the rest, but if he fails he is the victim of prospector's luck and the loser. The suspense towards the last is what makes the game amusing.—DONALD W. CLARK.

Hammering Metal Trays

(Continued from page 81)

not to drive the work out of shape to any great extent. You will soon get the knack of it.

Frequently, lay the tray upside down on a flat anvil surface and straighten it out. Be sure to anneal it several times during the operation. The procedure is the same for triangular,

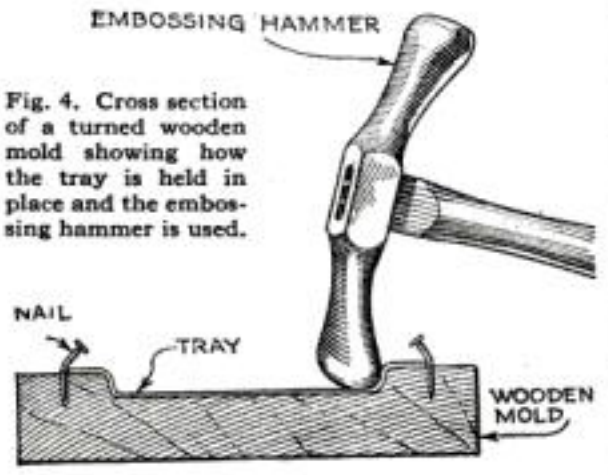


Fig. 4. Cross section of a turned wooden mold showing how the tray is held in place and the embossing hammer is used.

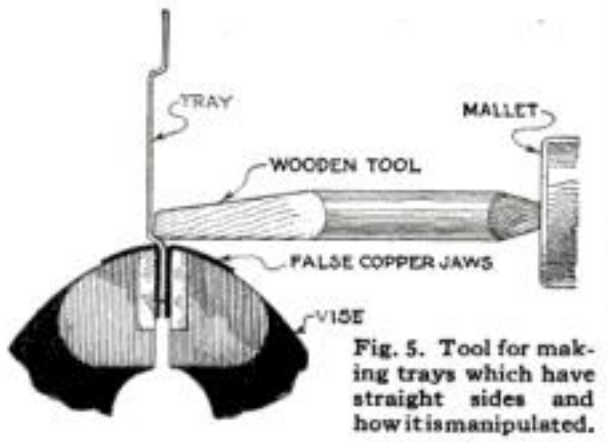


Fig. 5. Tool for making trays which have straight sides and how it is manipulated.

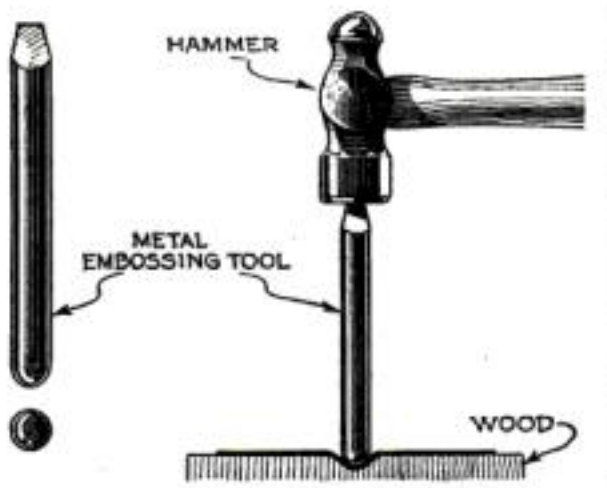


Fig. 6. Method of ornamenting trays with an embossing tool, which is used like a punch.

hexangular, and other trays with straight sides.

Any of the trays can be decorated by laying them upside down on the end grain of a block of wood and driving up the metal with a blunt center punch in such a way as to form a pattern of raised dots or "bosses" as shown in Figs. 2 and 6. The embossing tools may be filed from mild steel rods as shown in Fig. 6. Boltheads may be used to make large embossing tools.

A cold chisel with a blunt edge will form a raised line but care should be used not to break or cut through the surface of the metal. Sometimes the work is placed on a block of lead for this embossing work.

In the next article of this series the making of simple bowls will be explained.

Landing Gear for Models

(Continued from page 106)

easy to assemble your model, the front floats described last month and shown in Blueprint No. 102 (see page 108) were arranged to slip into small sockets on the inside of the A-frame, and four small hooks were used to hook the silk thread bracing to the A-frame cross brace at the front and to the center cans on the A-frame behind, thus holding the

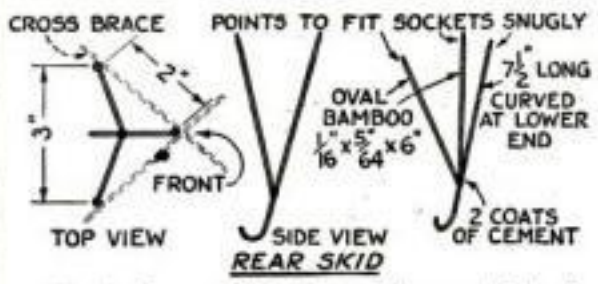


Fig. 4. Top and side views of the rear skid and an explanatory sketch drawn in perspective.

floats securely in position. With the parts all made, we are now ready to assemble our landing gear in the same way.

Take another look at Figs. 2 and 3 and study the manner in which the parts are joined. It is easier to fasten the wheels to the crosspiece first by cementing on the axle. Do this so that the wheels are parallel to each other and run smoothly. Then fasten the two struts to the crosspiece as close to the wheels as you can. Be sure that they are set at the proper angle. It is well to use two coats of cement on the strut junctions, as they are subject to considerable stress in taking off and landing.

Next, taper the outer ends of the vertical struts so that they will fit into the sockets on the frame. Fit the assembled chassis to the frame and carefully attach the silk thread

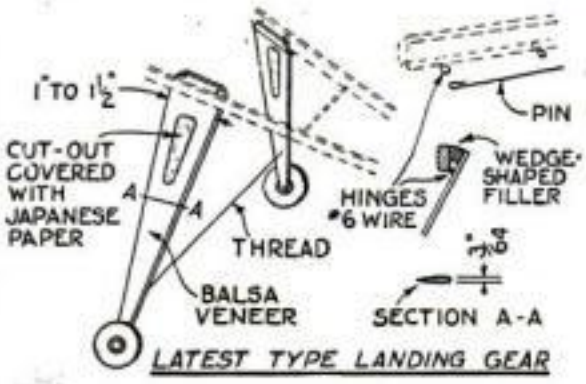


Fig. 5. A new type of front landing gear for advanced model makers to experiment with.

bracing, which should be neither too tight nor too loose. Note that the front threads do not cross and that the small wire hooks are fastened on the front bamboo cross member of the frame. The rear silk threads, however, cross and are then hooked to the center cans on the frame.

To make the regulation type model tail skid, split two pieces of bamboo 1/16 by 5/64 by 6 in. and shape them to an oval section. Make a third piece 1/16 by 5/64 by 7½ in. and oval in section. Bend one end of this piece as shown in Fig. 4 to form the skid.

With these three parts carefully made, you have only to assemble them as shown. Remember that the upper ends of the tripod pieces should be made to fit into the sockets on the frame of the model so that the rear skid can be disassembled quickly, the same as the front chassis.

Titles for Amateur Movies

IN MAKING titles with amateur or 16 mm. moving picture film, use 2 ft. of film for every four words if the title exceeds eight words. For a title of less than eight words, use 2 ft. of film for every three words. It is not good practice to use less than 2 ft. for any title.—H. N. W.

Who Can Match This Shop?

(Continued from page 79)

torches and both plain and electric soldering coppers; the bottom part has fire bricks and accessories for brazing and welding, as well as various electric heaters and gluepots.

The general workbench is shown in Fig. 3. On the bench is a combination motor-driven machine, including a lathe and a circular saw, the portable motor of which can be used to operate either the bench drill or the scroll saw at the right of the lathe. At the left is another portable motor for drilling, and grinding.

In Fig. 4 is shown part of another large room. The woodworking bench in the center carries a motorized bench shop consisting of circular saws, planer, sander, and drill, as well as a heavy woodworking lathe with a 4 ft. long bed.

Fig. 6. Cabinet containing wood and metal working tools, including micrometers, taps and dies, assorted C-clamps, and wrench sets.

At the rear is a large motor-driven jig saw and a high-speed lathe.

The rear of the woodworking bench is shown in Fig. 5. In this part of the shop is a small band saw, a rack for lumber, and also complete equipment for painting. Mr. Stuhler has found an electric shaper and a jointer to be almost indispensable for making moldings and doing cabinetwork, but these machines are not illustrated; neither is a portable electric sander.

The tool cabinet shown in Fig. 6 is 8 ft. high and 10 ft. long. It contains tools for both wood and metal work, including carving tools, micrometers, gages, taps, dies, and miscellaneous tools, all of nationally advertised makes. To mention the manufacturers of the tools and machines used by Mr. Stuhler would be to call the roll of the tool and machine advertisers of this magazine, as he made up his mind in the beginning to purchase nothing but equipment of high quality and well-proved durability.

Small Crucible Made from a Battery Carbon

WHEN the amateur mechanic wishes to make small castings of brass, aluminum, and various alloys, he can make a crucible from an old dry cell battery carbon. Take out the carbon, secure it firmly, and drill as large a hole as practical—ordinarily ½ or ⅝ in.—through its center to within about ½ in. of the bottom. Scraps of the metal to be melted can be placed in this hole and the carbon heated in any available flame. A small coal forge has been found convenient, for the coal may be packed closely around the carbon, holding it upright.—OLIN ATWOOD.

A PUNCHING bag to amuse the children can be made by inclosing an old inner tube in a sack. The tube should be doubled in such a way that the valve is folded in toward the center of the punching bag. An old pair of gloves should be used to protect the children's hands from abrasions.—JOHN BOSCOVICH.

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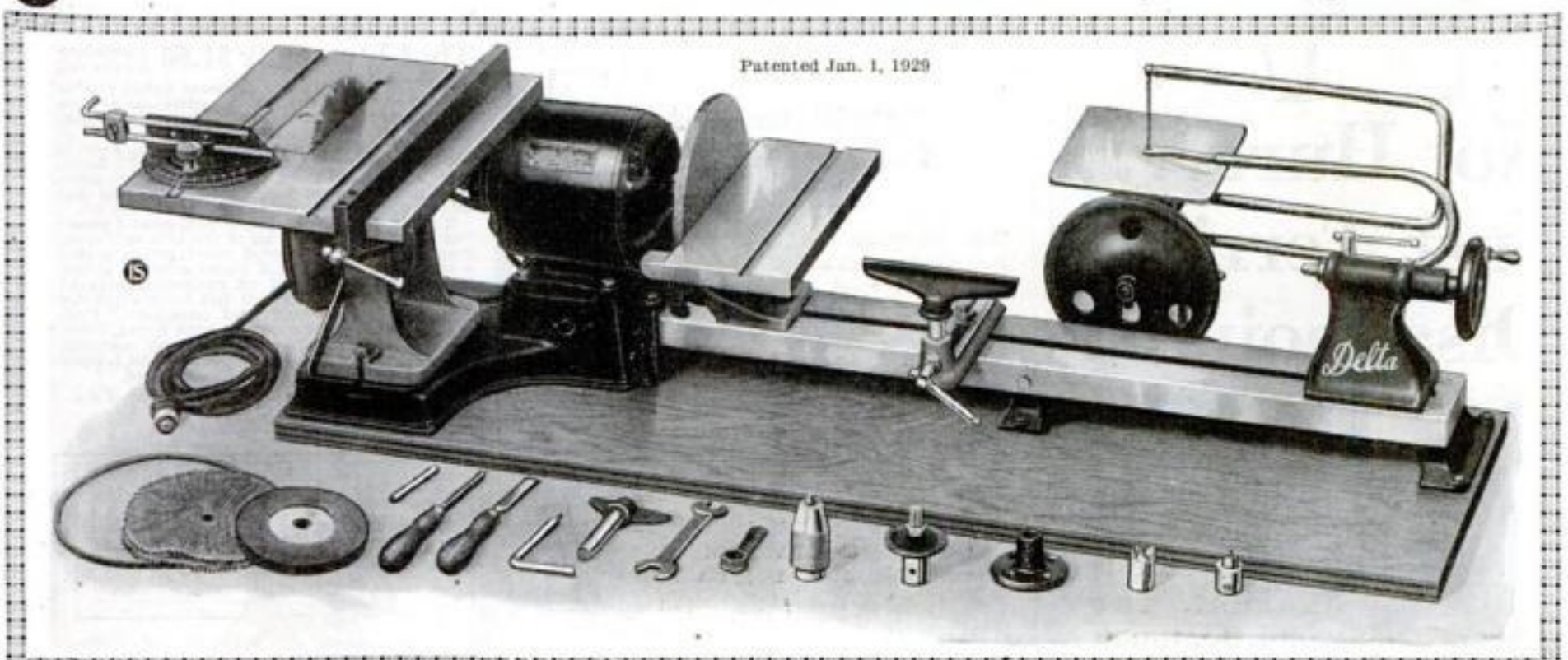

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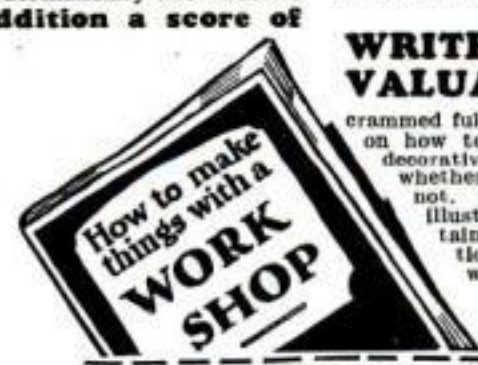

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Heavy-Duty Workbench

(*Continued from page 94*)

drawer as required by the size of the opening.

22. Cut out a slot in the apron so that the drawer may be opened without using handles.

23. Bore ¾-in. holes in the apron and perhaps one or two in the rear leg where pegs may be placed to support wide boards on edge for planing.

24. Fit an iron bench stop, placing it about 3 in. from the front edge of the bench top and not nearer than 6 in. from the left end.

Materials for Bench

What Lumber to Order

Part	No. Pcs.	T.	W.	L.
Top (pine or maple)	1	2	8	14 ft.
Bottom for trough and lower cross rails	1	1	8	16 ft.
Aprons	1	1	12	14 ft.
Shelves, upper cross rails, and stretcher	1	1	12	18 ft.
Drawer	1	1	6	8 ft.
Legs	1	2	4	6 ft.
Legs	1	2	10	6 ft.
Vise jaw (maple)	1	2	8	2 ft. 6 in.
Follower (maple)	1	1	4	2 ft. 6 in.
Back for vise (maple)	1	1	8	2 ft. 8 in.
Strip for tool trough	1	1	1¼	12 ft.
Drawer bottom (3-ply)	1	¼	24	24
Dowels (birch)	1	½ dia.		18 in.

All dimensions are in inches (and all material is hard pine, dressed four sides) except as noted. This lumber, because of the waste in planing, will be less in thickness and width than stated here; 1-in. boards D4S are about 13/16 in. thick, for example.

Hardware

1 lb. eightpenny box nails
½ lb. sixpenny box nails.
1 screw for vise.
1 bench stop.
1 small machinist's vise (if desired).
1 dozen 2½-in. No. 12 flat-head bright screws.

Sizes of Finished Pieces

Part	No. Pcs.	T.	W.	L.
Top	2	1¾	7½	7 ft.
Top	1	13/16	7¼	7 ft.
Top	1	13/16	1¼	7 ft.
Aprons	2	13/16	11½	7 ft.
Upper cross rails (end rails)	2	13/16	10¾	21⅜
Upper cross rail	1	13/16	5	21⅜
Lower cross rails (cut from 1 by 8 in. board)	3	13/16	3½	21⅜
Drawer rails	2	13/16	9	21⅜
Shelves	2	13/16	8	21¾
Stretcher (cut after bench is nailed up)	1	13/16	9½	6 ft.
Legs	2	1¾	3½	2 ft. 6 in.
Legs for vise end (pine)	2	1¾	9½	2 ft. 6 in.
Backing for vise (maple)	1	13/16	7½	2 ft. 8 in.
Vise jaw (maple; cut top end after fitting vise screw)	1	1¾	7½	2 ft. 5 in.
Follower for vise (maple)	1	13/16	3	2 ft.
Drawer front (pine)	1	13/16	6	2 ft. 4 in.
Drawer sides	2	13/16	6	20
Drawer back	1	13/16	5½	26¼
Slats to support drawer	4	13/16	1¼	20 in.
Drawer bottom (cut as needed from 3-ply).				

All dimensions are in inches except as noted.

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 9

Hints for Home Owners

(Continued from page 102)

Fig. 3. Rubbing paraffin on a porous saucer.

corner of the bathroom door and down the edge of the door jamb, and fastened at the lower end to a screw eye about a foot from the floor. This arrangement is not unsightly and may be instantly located by all. A pull lights or extinguishes the lamp.—CHARLES F. H. MILLS.

EARTHENWARE saucers used to support flower pots often permit moisture to soak through to the bottom, with the result that painted or varnished surfaces are damaged. This can be prevented by waterproofing the saucer with paraffin. After the saucer has been heated in an oven or over a flame until sufficiently warm to melt the paraffin, it is rubbed with a piece of wax (Fig. 3). The porous saucer absorbs the melted wax but does not change its color.—W. E. B.

OFTEN those who live in apartments and other restricted quarters are seriously inconvenienced by the lack of adequate space for storing clothing in such a way as to permit easy access to any particular article. The device shown in Fig. 4 will extend the capacity of an overcrowded closet by as many suit hangers as the length of the wooden arm will permit, yet it will not interfere with articles hung elsewhere in the closet. The arm may be made longer than indicated, or the hooks may be placed closer together if only light articles are to be hung on them.

Make the arm ⅞ by 2¼ by at least 12 in., shaping it about as indicated. Place ½-in. hooks on the underside at *A*, a screw eye in the top at *B*, and a 1½-in. No. 10 round-head screw in the end at *C*, boring a small hole to receive the latter without splitting the wood. Place a 2-in. hinge at *D* and fasten the arm to the door as shown, so the end of the arm will clear the top of the doorframe when raised. Place a ½-in. hook at the top of the door and fasten a light chain or cord to the hook and to the eye *B*, making it just long enough to support the arm horizontally as indicated. A key ring in the hook may be easily slipped over the screw *C* when the arm is lifted up for closing the door.—CHARLES A. KING.

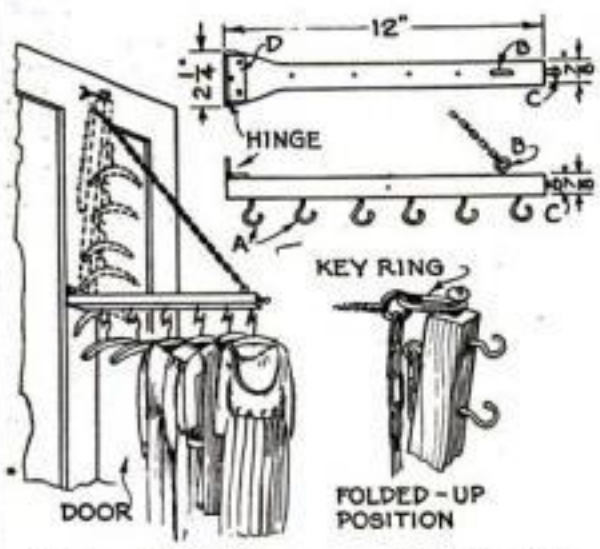
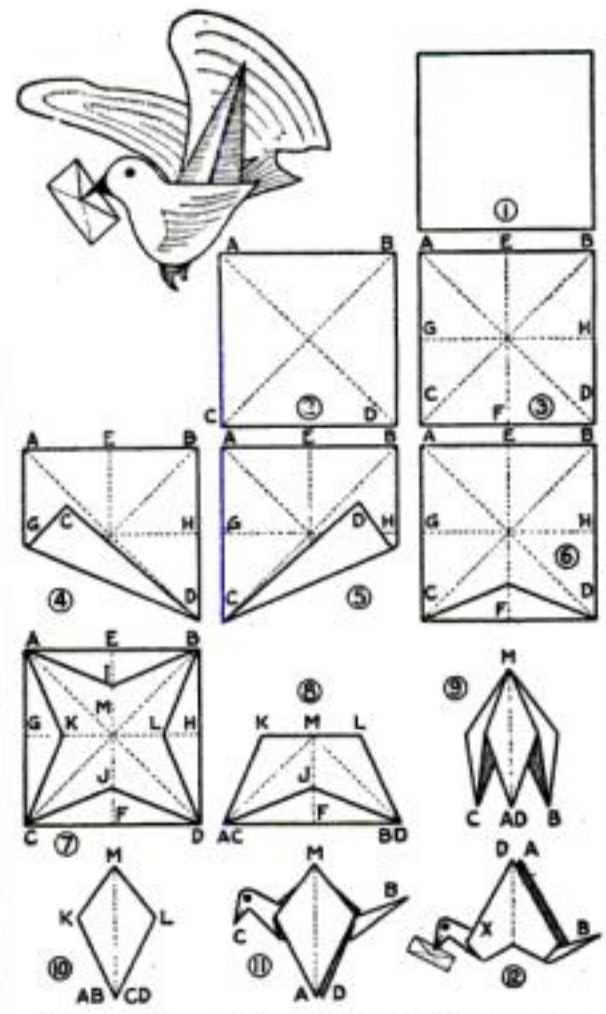


Fig. 4. This folding arm on the back of a closet door holds several extra clothes hangers.

Paper Bird Flaps Wings When Tail Is Pulled



How to fold the basic form to which various bird and butterfly shapes can be attached.

BY FOLDING a single sheet of paper as shown, you can make a bird which will flap its wings when its tail is pulled. Different wings, bodies, heads, and tails can be pasted on the elementary form. Butterflies can be made similarly, and it is also possible to construct animals with ears that flap.

The steps in folding the bird are as follows: 1. Prepare a square of paper of any convenient size. If you wish to make a canary bird, paste yellow lawn on the paper. 2. Crease the diagonals *AD* and *BC*. 3. Crease *EF* and *GH*. 4. Crease *CD* to center of square. 5. Do likewise with *CD* in the opposite direction. 6. You now have a triangular crease from *C* to *D* at one edge of the square as indicated at *F*. 7. Crease the other sides of the square similarly to form a star figure; then spread the square out flat. 8. Tuck in triangle *ACK* and *BDL* (see Fig. 7), at the same time folding the paper in half along *KL*. 9. Similarly, tuck in triangle *CDJ* and *ABI* (see Fig. 7), folding the paper at the same time along *IJ*, so as to obtain a figure like a partly opened umbrella. The points *F*, *E*, *G*, and *H* are inside toward the center. 10. Fold *AB*, *CD*, *JK*, and *IL* together flat on the table in front of you. 11. Raise corner *C* to bring out the neck. Crease down corner *C* to form the head and beak. Raise corner *B* to form the tail. 12. Raise *AD* to form the wings. Paste the letter in the bird's beak.

To operate the bird, hold it where marked with a cross in Fig. 12. Curve the wings slightly and pull the tail.—JEANNE I. ORSINI.

Winding Cord in a Ball

WHEN winding clothesline or other heavy cord into a ball, all kinking can be avoided if the ball is changed at intervals from the right to the left hand and vice versa. Wind with one hand until the cord begins to twist; then transfer the ball to the other hand without turning it around or changing the direction of winding. When the cord has become unkinked and starts to twist in the other direction, change hands again.—ROGER SLOAT.

Einstein's Topsy-Turvy World

(Continued from page 19)

approaching the speed of light, which Einstein says cannot actually be reached by any material thing—loses as much as three feet of its length, only to regain it when it stops.

Until recently such ideas, involving almost unimaginable speeds, might have been of only philosophical interest—but now we have discovered at least one speed king of the physical world in the apparently material particles that radium shoots off at nearly the speed of light. In view of Einstein's discoveries, only his theory can detect their real nature.

To understand Einstein's purpose it is worth while to go back a few years, and to see just how his work clears up difficulties that have bothered physicists for centuries. In Newton's time, as Einstein himself points out, "space," such as the void that separates the earth from the sun, was considered a dead, empty sort of thing. Obviously it had nothing to do with arrows and bullets; it was just a sort of a stage upon which the sun and the earth, peopled with human beings, performed as actors.

A VERY satisfactory idea—until, in the eighteenth century, Huygens, Young, and Fresnel—Dutch, British, and French physicists—came along with the notion that light was made of waves. The daylight that reached us from the sun was a series of ripples in something or other—but in what? The idea worked too well in the laboratory to discard, so physicists invented an imaginary "ether" and plugged supposedly-empty space full of it.

It was an ingenious if not a wholly convincing explanation, and for generations no one could do any better. Then Michael Faraday proposed the bold theory that the ripples of light, once started on their way, sever relations completely with their source and splash along on their own initiative. That seems a natural assumption now, but even the boosters of the "ether" idea had hesitated to give the mythical gas the responsibility of carrying just "waves" with no apparent source.

MAXWELL, with his inspired formulæ, discovered that the waves of light were really electric—a revolutionary idea. On his heels came Hertz, in Germany, to show that what we know now as radio waves are just as electric as light, and that the only difference is one of the length of the waves. Gradually the conception dawned upon the scientific world that light, radio, and X-rays, to say nothing of the recently-discussed ultra-violet and infra-red rays, are all pretty much the same thing—little bundles of electric force, vibrating at different rates as they speed through space. But—and here was the catch—the only way, still, that people could explain how those little bundles got from one place to another was to say that they rippled through "the ether."

Enter Einstein. "Away with this imaginary ether," he said, in effect. "This space, which you have been squirting full of an impossible gas, is not as dead as you have imagined. Live, vibrating space plays a part in every electric or mechanical action."

Einstein brought space to life, by enriching it with the "fourth dimension" of time—in his "Special Theory of Relativity," published in 1905. By doing so he achieved two outstanding feats. First, he showed that electricity and magnetism, which heretofore were thought of as distinct forces, were the same thing! Second, he discovered that a material object can lose weight, which becomes transformed into electricity. In other words he revealed that mass can turn into energy, contradicting the notion that mass was indestructible and that the amount of energy in any system could not change. (Continued on page 134)

Einstein's Topsy-Turvy World

(Continued from page 133)

Application of this second idea came only last summer, when Dr. Robert A. Millikan, California Institute of Technology physicist, discovered that strange "cosmic rays" from the stars were formed of the energy left over when atoms merged violently together to form new elements, losing a part of their weight.

Einstein's "Special Theory," however, left unexplained the mysterious force of gravity. Even Newton, who deduced the famous laws telling how strongly gravity acts, made no attempt to account for the way the earth apparently pulls things to it. In 1915 Einstein announced a new "General Theory of Relativity" that offered an explanation of gravity.

This mysterious force, he said, is not a whit different from the force that holds up a stone swung in circles on a string, or that tips over a car going too fast around a curve—hitherto known as "centrifugal force." There is nothing mysterious about it—it is just a mechanical effect that anyone can conceivably duplicate, irrespective of the earth.

IF, HE pointed out, you were to stand inside an elevator somewhere out in space, away from the earth, and have the elevator hoisted straight upward at a constantly increasing speed—going twenty miles an hour faster each second—your feet would press against the elevator's floor just as firmly as they now do against the ground when you walk.

It needed some queer geometry to extend this idea to the forces that move the earth, moon, sun, and stars—but Einstein managed it. It led to remarkable results. Instead of acting instantaneously, as Newton had supposed, evidently gravity moves through space with the speed of light. More important, Newton's laws of gravity needed a slight correction when they were applied on a large scale. Einstein made such a correction, applied it to predict the shifting of stars, and his prophecy was duly vindicated. At the same time he made another prediction that was not verified until 1923. He said that distant stars, if carefully examined through a spectroscope, should show a peculiar reddishness. At Mt. Wilson Observatory, California, Dr. Charles E. St. John observed this effect in certain dense stars and found that it agreed exactly with Einstein's calculations.

ONE goal remained. Einstein's special theory dealt with electricity; his general theory explained gravity, but along a separate line. It remained to reconcile the two under a general law.

Now he has linked them in relativity's third triumph—the "Field Theory." Dr. Edwin Schroedinger, of the University of Berlin—author of our most recent conception of the atom, a rather severe critic of the "general" Einstein theory, and the advocate of another theory that differed from it in important points—admits that Einstein's new theory is the best explanation yet advanced of the connection between electricity and gravity.

Many experts, however, are not yet convinced that Einstein is right. Some of them condemn his ideas completely; others are exemplified by Prof. Albert Michelson, American physicist famous for his measurments of light, who recently declared in substance: "I am now ready to accept the consequences of the Einstein theory, even though I believe that he has made correct results grow from incorrect assumptions."

Meanwhile, according to Prof. Freundlich of the Einstein Institute, it will take between two and five years for the few men who can understand the latest advance to study it, find out what it is all about and test it. It may be ten years, experts agree, before we may expect practical benefits from the latest feat of human imagination.

Glimpses of People Worth Knowing

(Continued from page 20)

distinguished Norwegian explorer, scientist, and statesman, is planning to revisit the Arctic in April of next year.

Thirty-six years ago, he started out on the polar expedition which made him a widely known figure, in the *Fram*, a stout wooden sailing vessel of his own design. On his next trip into the white wilderness Dr. Nansen will use the *Graf Zeppelin*, the giant dirigible designed and built by Dr. Hugo Eckener, who flew her across the Atlantic last autumn and who may pilot her during the Nansen expedition.

Dr. Nansen announced the other day that he intends to fly from Leningrad, Russia, to Nome, Alaska, a distance of 4,000 miles. The direct purpose of the Arctic survey will be to determine the exact extent and depth of the Polar Sea, but its ultimate aim is the establishment of a complete system of weather stations in the Arctic regions.

The expedition will be the crowning achievement of a career of unusual romance and adventure. Dr. Nansen's hope is to complete the work he started in 1893, when, on foot, with only one companion, he advanced 184 miles nearer to the North Pole than any one had then reached. But his career as an explorer began earlier than that. When only twenty-one, he visited the east coast of Greenland to secure rare zoölogical specimens. Six years later, he made a journey across the inland ice of Greenland.

His polar trip in the *Fram* made Nansen world-famous. On his return to Norway, he was showered with honors. He became one of the leaders in the movement for the separation of Norway from Sweden. In 1906 he was appointed Norwegian minister at London. Two years later, he resigned to accept the position of professor of oceanography in the University of Oslo, his Alma Mater, a place he has held, with few interruptions, ever since.

Immediately after the war, Dr. Nansen was made chairman of the Norwegian Association for the League of Nations. In this capacity, he carried on relief work for the starved populations of Russia and Asia Minor with such ability and success that he was awarded the Nobel Peace Prize in 1922.

An Honest Safe-Cracker

THE police of New York City recently had a perplexing problem. In the cellar of a house that had belonged to Arnold Rothstein, murdered gambler, a huge vault had been discovered. The police wished to open it. Several experts failed.

Then a smiling young chap walked into the cellar, tinkered a bit with the combination of the outer vault door and, without the aid of a single tool, had it open in three minutes. The inner door was fastened with an intricate key lock. A hole was drilled. In twelve minutes this door, too, was open.

Robert S. Murray, the man who cracks safes for an honest living, has reduced this strange profession to a science and an art. In the past fifteen years, he calculates, he has opened 15,000 safes. In the last eighteen months, the number has averaged between three and four a day.

Murray has opened safe doors on which operations had been started by burglars who had forgotten large charges of dynamite in their hurried departure. He has assisted in locating love letters, blueprints of inventions, and family heirlooms. His services are solicited from all parts of the country. His longest job was done in a little Indiana town, where he labored thirty-six hours at a stretch with but two hours off. In contrast to this siege with one safe, he once opened 104 safes for the United States Ship- (Continued on page 136)

Glimpses of People Worth Knowing

(Continued from page 135)

ping Board in three days at Norfolk, Va.

"How do I do it?" says Murray. "I can't tell you. It is a knack that comes only with experience. My technique, if I may so call it, is my own."

Murray, who was born in Danville, Pa., started as a mechanic in a small Ohio town. When he was twenty, his father, brother, and himself bought out a safe agency in New York. He was instructed in the rudiments of honest safe-cracking by an expert and has been cracking safes ever since.

An Engineer-Farmer

A HANDSOME, fashionably-dressed man boarded a steamer for Russia the other day. He sailed to aid the Soviet government in developing 10,000,000 acres of grain land. The vessel's passenger list named him as "Thomas D. Campbell, farmer, Harden, Montana." That one line concealed a remarkable story of successful application of scientific and mechanical ingenuity to the farm problem.

Campbell is the world's largest wheat grower. He farms approximately 100,000 acres, which yield an average of almost 3,000,000 bushels a year. On his giant farm, one solitary horse may be found—Campbell's saddle horse. Five thousand horses are dispensed with by his machines. These include 109 tractors, 500 plow bottoms which can cover about 1,000 acres a day, 100 planting machines that can drill and seed 3,000 acres a day, eighty binders which can cut from 1,500 to 2,000 acres a day, six twenty-four-foot "combines" capable of harvesting and threshing 300 acres a day, and eleven large threshing machines which can turn 20,000 bushels a day. In addition, there is a big fleet of cars and trucks, among them 100 six-ton grain wagons, drawn by tractors, that carry the threshed grain from field to elevators; thirty-five passenger autos and trucks, and many fireproof steel storage bins, all movable and on skids and with a capacity of 100,000 bushels of grain.

Each day on Campbell's farm there is plowed the equivalent of a furrow ten feet wide extending from New York to Chicago. His tractors daily consume more gasoline than all of the Fifth Avenue buses in New York City put together. One machine he has perfected, operated by two men, seeds an area sixty feet wide and three miles long every hour, or a total of 200 acres a day. Another machine plows, disks, seeds, packs, and harrows in one operation thirty acres a day; it, too, is operated by two men. Still another harvests, threshes, and loads grain in trucks at the rate of fifty acres a day at the cost of a dollar an acre.

No wonder that Campbell says, "I am really not a farmer; I am a mechanical engineer. We manufacture wheat almost instead of raising it. I have no farm hands, but skilled labor, drawing salaries as high as the proverbial plumber. Most of my men are engineers themselves."

Campbell started this tremendous enterprise as a patriotic service to his country when there was a grain shortage during the war. He began by offering the Government his services as a dollar-a-year man. This was not accepted. Instead Secretary Lane, of the Department of the Interior, assigned to him 200,000 acres of Indian land in Montana and Wyoming, so arid that horses can scarcely survive on it. In a little more than ten years, Campbell, from this dry waste, has wrested more than 100,000 acres yielding twenty-nine bushels to the acre at such low cost that the much-mooted "farm problem" doesn't worry him.

A Machine That Makes Heroes

(*Continued from page 23*)

eight-tube receiving set equipped with earphones. This set handles wave lengths from 500 to 1,100 meters, and is tuned like any other radio set. A light, which flashes in unison with the dots and dashes of code, enables a pilot to read signals while standing at the other side of the room.

At the top of the main case or binnacle is a "dummy" compass, a flat metal scale marked off with 360 degrees, with zero pointing toward the ship's bow. Above the compass is a wire stretched across wishbone-shaped prongs attached directly to the shaft and turning with the loop aerial. When a hand wheel on the shaft is revolved, it turns the aerial on the roof and the wire over the compass. The wire is at right angles to the plane of the loop, so when the open side of the aerial faces the source of a radio signal, the wire points directly toward it. The reason for this is that the point of lowest signal strength is the one used to determine direction. It is difficult to pick a point of loudest volume, but relatively easy to determine the position of least volume, just before the complete "fadeout." When this is found, the wire, pointing at right angles, aims directly at the calling ship.

All radio compass bearings are taken with reference to the ship's head. If a signal comes from directly in front, the wire points to zero on the "dummy" scale. If it comes from one side or the other, the wire indicates the number of degrees to left or right and the ship's course is altered in that direction. In some ships, including the *America*, the "dummy" compass is replaced with a magnetic or a gyro compass. In this case, the wire indicates the position of the calling vessel in respect to north as well as in respect to the ship's course.

BESIDES playing a stellar rôle in sea rescues, the radio compass enables a captain to determine his own position in a fog. He need only listen to a shore beacon station, mark the line of its incoming signal on his chart from the beacon's charted position, then listen to a second beacon station and do the same thing. Where the two lines cross at sea is the location of his ship.

An air craft, flying above the clouds or through fog, can discover its position by a slightly different application of the radio compass. The pilot sends a wireless message to two landing fields, some distance apart. A compass at each field determines the line from the field to the flying plane. Its position—where the two lines cross—is figured out on the ground and radioed to the flyer.

In practically all important lighthouses along the United States coast radio beacons have been established. Each sends out a characteristic dot and dash signal which identifies it to any vessel. During one month, they transmitted approximately 200,000 radio compass bearings to ships and air craft.

THE compass also prevents collisions in fog, for the positions of near-by ships can be determined when they cannot be seen. The latest development is a miniature radio beacon transmitter which can be wheeled about the deck of a ship, plugged in to its current supply, and made to transmit a characteristic signal warning to other ships in the vicinity.

Landsmen, as well, may soon benefit from the use of the radio compass. Tests are now being carried on by the Navy Department, in Washington, D. C., to determine the approach of storms by its use. The compass shows the point from which static comes with greatest intensity, indicating the seat of electrical disturbances from which storms may be expected. Future years undoubtedly will find this wonderful instrument of rescue performing still wider services.

Witches—Still on the Job!

(Continued from page 45)

old German word "hagadisse," meaning spirits in female form. In Germany it became shortened to "hex," and in the tongue of the Anglo-Saxons, who took it with them to England, to the word "hag."

Africa is still under the spell of witchcraft. The witch-doctor is an important personage, doing a thriving business in charms and incantations. Professor Clark Wissler of the American Museum of Natural History says that witchcraft is still practiced among the South American Indians living along the banks of the Amazon river, among people in southern Europe, India and Australia, and among Indians in parts of North America. For believers in witchcraft the power of suggestion is such that it may lead directly to the death of one who is convinced that he has been "hexed." Sixty percent of the deaths among the natives of West Africa are believed to result from belief of the victims that an evil spell has been cast upon them. In Haiti and among the negroes of the Mississippi Delta the "voodoo" is still all-potent.

WITCHES work in divers ways, but almost everywhere they demand some object which the victim has worn in order to cast an effective spell. A lock of hair is considered the best of all. To ask an Eskimo for a lock of his hair is to court death, for it can be wanted for only one purpose, that of bewitching its owner.

There are many tests for witches among tribes which believe in them today, similar to the test used in Europe only a couple of hundred years ago. Matthew Hopkins, England's most famous witch-finder, who was at last hanged himself for witchcraft, had certain definite means by which he claimed to determine whether a person was a witch. Sticking a needle into the body was one of them; if the victim felt no pain he was a witch! Inability to shed tears or to repeat the Lord's Prayer as well as the practice of walking backward or against the sun, were considered other signs. One test was to place the accused witch in one scale of a balance and a Bible in the other; if the accused weighed more than the Bible, he or she was certainly a witch! Women were sent to the gallows on no stronger evidence than that, as late as 1712.

In India today a test of the witch is the ordeal by fire; if one is innocent of witchcraft the fire will not burn him. Another test which seems to be used wherever witchcraft is believed in is to tie the accused's right toe to his or her left thumb, the left great toe to the right thumb, and cast the witch into the water. If he or she sinks, innocence of witchcraft is proven, for water will not receive a witch! The net effect on the accused is death in either event.

CHARMS and incantations against witches are still in use among people who call themselves civilized. When you touch wood after boasting of good health, that is a survival of the ancient superstition that a witch cannot harm you if you take refuge behind a tree. Throwing a pinch of salt over one's left shoulder after accidentally spilling the salt is another familiar practice, indulged in by many people today, which dates back to the earliest beginning of witchcraft, and so is the habit of the Italian peasant of crossing his fingers to ward off the "malocchia" or evil eye.

When Shakespeare wrote "Macbeth" all the world believed in witches, and there was nothing implausible about the incantations and predictions of the weird sisters. But who would have looked for witchcraft in modern America, in the heart of Pennsylvania, less than a hundred miles from the most thickly settled and sophisticated part of the United States!

Switching on the Sun!

(Continued from page 27)

out the carbons of arc lamps and filling them with various substances. When he found the light he sought, he continued experimenting. One of his chance discoveries was a light that duplicated sunshine even more closely than the old type of all-carbon arc. Its source was a carbon filled with the rare earth metal, cerium, ground into a paste and forced into the black sticks with hydraulic presses.

WHILE the carbons can be used in any carbon arc lamp, the maker has added a screen that excludes the few rays that are not found in natural sunshine. The result is a lamp that contains not only the same kinds of light found in sunshine, but almost exactly in the same proportions. A chart reproduced here shows the extent of the duplication claimed. Furthermore, it is pointed out, some of the extremely short ultra-violet rays, as apparently shown by recent research, have the curious property of neutralizing some of the others' benefits; they are carefully screened off.

Other types of carbons have been developed for special medical uses. They may be used in a home lamp under a doctor's prescription. One, filled with an iron core, gives a bluish light rich in rays that have been used to treat surgical tuberculosis. Another is used especially for rickets; it is filled with several metals. A carbon cored with the metal strontium gives a red light containing heat rays that relieve internal congestion.

Once more it should be emphasized that the sole justification of a health lamp in non-professional hands is *to keep a well person well*. It should never be used to treat sickness without a doctor's advice.

More Elements to Find

FROM W. W. Andrews, of the General Electric Company, recently came the statement that there may be other elements beyond the ninety-two in the accepted list of the "building stones" from which all matter is made.

The difference between one element and another is in the number and arrangement of electrons, or particles of negative electricity in each of its atoms. The hydrogen atom has only one electron, the helium atom two, and so on up to uranium, the densest of all known substances, with ninety-two electrons in each of its atoms.

There has been no evidence and, until now, no suspicion of substances in the universe of greater atomic weight than uranium yet Andrews points out that the same mathematical laws which led to the deduction of some of the known elements indicate the hypothetical existence of an element which would be No. 118 in the extended scale, and which he calls "hypon," because its existence is purely hypothetical. He imagines hypon as existing under enormous pressure in the core of some sun in outer space. He suggests that the occasional appearance of a brilliant star or "nova," which flames up only to die down in a few months or years, is due to the release of pressure on the hypon core of an unknown celestial body, causing the entire star to disintegrate and its electrons to rearrange themselves into other and familiar elements. He holds that the elements which we know may be only the end products of atomic disintegration through the ages, created through just such means.

Hypon would be immensely denser and heavier than anything we know. There is ground for belief that in some of the regions of space, elements exist which are so dense that a handful of one of them would weigh on the order of tons if measured on an earthly scale. There is little likelihood, however, of the discovery of these elements themselves.

Running a Skyscraper

(*Continued from page 31*)

dynamos, operating day and night, with a total capacity of 1,500 kilowatts. We have two 500-kilowatt units and one 200-kilowatt unit. These are, of course, of different sizes, so that the changing electrical loads of the building may be taken care of with maximum efficiency. During the night, when there is a smaller demand for light, we switch from the more powerful units to the less. The plant is capable of generating sufficient power to operate an electric street railway or to supply electric light for a city of 50,000 inhabitants. It furnishes the power to operate all our elevators—twenty-seven in number—the lathes in the machine shop, the heat for 1,900 radiators, the light for our 80,000 bulbs."

In the near-by boiler room ten men, their faces blackened, were firing the gigantic boilers.

"Forty-two tons of coal go into those hungry monsters every day," said Mr. Smith. "If harnessed together they could lift a hundred Statues of Liberty without straining."

I INQUIRED how the skyscraper city was supplied with fresh air.

"For the first few floors," Mr. Smith explained, "we operate a ventilating plant which furnishes a complete change of air in the three stories underground and the first four above, four times in every hour. Fresh air is drawn down from outside the building above the sixth floor and passed through fine sieves and a curtain of running water, where it is washed. In summer, we cool this air by refrigeration. In winter, we warm it by heated pipes."

The twenty-seven electrically-operated elevators are of supreme importance in transporting the building's thousands of inhabitants to and from their work, particularly during the rush hours at 9 o'clock in the morning, at noon, and again at 5 o'clock in the evening. Six of the elevators are "high rise" cars: two run to the fifty-fourth floor, with the first stop at the thirty-sixth, and four to the forty-seventh. From the fifty-fourth to the fifty-eighth floors runs a shuttle. In the Woolworth Building you can take the longest and fastest express elevator ride in the skyscraper world.

Suppose one should drop? Well, one has never dropped, but if one should, it would land on air. The Woolworth elevators represent a first experience in tapering shafts. If by any chance the hoisting cables of a car should break, the elevator would drop onto a column of compressing air and come to a slow and gentle stop. Yet, even to prevent that experience, the elevators are inspected every day.

AN INSPECTOR made a test some time ago of one of the "high rise" cars. It was loaded with 7,000 pounds, topped by a glass full of water, and let loose from the forty-fifth floor. The elevator came to a dignified rest without spilling even a drop!

The traffic cop of the perpendicular transit lines is John Graham, veteran elevator starter. He controls the movements of all cars and keeps track of them on an electric signal board which tells him the exact position of every car at every second. Every car has a telephone, so that its operator can be in immediate touch with Graham, whether the car is stalled or going at top tilt.

Naturally, there is a big force of workers in such a building. "Mayor" Smith has a staff of 239, ranging from lowly charwomen to high-salaried engineers. Some of the jobs seem, to laymen, dangerous. They aren't, according to Mr. Smith, and yet if an accident occurs there is an emergency hospital with a doctor and a nurse in constant attendance. It's quite safe to faint in the Woolworth Building, as many a luckless young lady has found out.

Indeed, with "Mayor" Smith on the job, this up-and-down city is perhaps the safest in the world.

Planning a 44-Mile Tunnel

(Continued from page 22)

in a passage that had been begun on the opposite side of the shaft.

As the tunnel progressed, other points were established at intervals of approximately a hundred feet. This was accomplished by lining up the wires behind, through the transit telescope, and then flopping the telescope over on its transverse axis and sighting ahead from the other side, using a Vernier scale to establish the next point within the thousandth of a foot of accuracy.

Such work must be six times as accurate as that done in ordinary city surveying. Its error must be no greater than one foot out of line in a distance of fifty miles! To insure against error at the start of the East River tube, twelve skilled engineers, one after the other, descended into the shaft and established independently the third point by lining up the first two wires. The average of their findings was then taken as the nearest approach to utmost accuracy.

AFTER the tunnel penetrated under the river, the difficulties of the alignment engineer increased. The sighting had to be done partly in free air and partly within the compressed air chambers where the "sand hogs" worked. In carrying the line through a bulkhead into the compressed air chamber, the transit was set up in the "air lock," the compartment in which the pressure is gradually raised to enable workers to enter the chamber. The outer door was left open and through it the wires behind were lined up. Then the door was closed, the pressure raised, and the door at the opposite end of the lock opened to permit the next point to be established by sighting out through it.

It is within compressed air chambers that the real work of all underwater tunnel digging jobs is carried on. The East River tube was typical of the process. Three locks, one for material, one for men, and an emergency lock, led through the bulkhead. At the nose of the tunnel was the $40,000 "shield," the giant steel hoop with forward cutting edges that protected the workmen from cave-ins. It was propelled forward in three-foot stages by a circle of powerful hydraulic jacks pushing against the heavy cast-iron shell of the excavated tunnel behind. In the manner of a monster cookie cutter, the forward end of the round shield bit into the dirt and rock ahead. This material was dug out, and the shield driven ahead again. At the end of each push, the jacks pulled forward, disappearing in containers in the shield, and leaving room for the addition of a new ring, thirty inches wide, to the iron lining of the tunnel behind. In the side of each ring a hole, later plugged, allowed gravel and grout (thin concrete) to be blown out to fill spaces outside the shell and thus strengthen the construction.

EACH ring of the tube shell was clamped in position with heavy bolts. Six rings a day was the maximum progress. The total weight of the completed iron tube was 17,300 tons. With the rings suggesting segments, the finished shell has the appearance of a huge, mile-long earthworm.

In making curves underground, the engineer is given tables that show the offset from the straight line at intervals of five feet. He determines the straight line and then sets the center mark of the tunnel to one side in accordance with the tables. In the iron shell, the curve is made by the use of tapered rings like those in a stovepipe. Usually every seventh ring has an inch and a half taper. Because the tunnel dips down under the river, the angle of descent and ascent has to be checked with equal care. A surveyor's level gives the angle of the slope, and tables tell the engineer what this angle should be at each point measured.

Slaying the Ice Monsters

(*Continued from page 53*)

degree. F. This first causes the ice to crack and then to explode. Using thermit is like pouring white-hot steel into a crack in the ice. When the metallic mixture is heated, the aluminum combines violently with the oxygen of the oxide to produce molten metal. The intense heat generated breaks the ice into its component gases—hydrogen and oxygen—and these form the high explosive that blasts out the jams. The flaming gases shoot hundreds of feet into the air while the frozen masses are rent asunder.

In the days when TNT and other high explosives were used in attempts to destroy icebergs, the work of the coast guard cutters' crews was filled with the thrills of constant danger. In small boats, the crews would row up to the bergs to lay the mines. When a berg could not be approached closely because of dangerous overhanging ledges, the mines were tied to floats and sent to drift against their mark.

THE methods used by Dr. Barnes in his thermit experiments on icebergs were of an entirely different nature. Equipped with spiked shoes, Alpine axes, and life belts, he and his party approached the bergs in a motor launch, towing a dory in which the thermit had been packed.

Three bergs were selected for the tests; the largest of them 500 feet long. The party, by means of scaling ladders and their axes, cut their way up the slippery side of the berg. Once on its center, a hole was drilled. Then containers of thermit were hauled up by ropes and the charges laid. Time fuses were attached to them. Charges weighing about 100 pounds proved the most effective.

The time fuses were fired and the party quickly drew off in its launch to watch the results. Ominous rumbling and crackling was heard. Suddenly, a flame shot 100 feet in the air! In a few minutes, the center fell out and half of the berg crashed with a roar to the water. The same procedure was repeated until each of the three bergs was destroyed. In all, a ton of thermit was used in the tests.

Within a few hours a jam of about 250,000 tons of ice was blasted out by three ninety-pound charges of thermit at Waddington, N. Y. At Oil City and Franklin, Pa., an enormous jam, twenty-five miles in extent, was broken up in this manner, without damage to property, in ten days. And at Chimney Island, Ogdensburg, N. Y., a million tons of ice was blown apart in nine hours with only two ninety-pound charges!

ATLANTIC icebergs, however, offer a more difficult problem. Often they are of tremendous size. Last year, the *Tampa* encountered a berg sixty-five feet high and 1,690 feet long. The officers calculated that it contained 36,000,000 tons of ice! The tallest berg sighted by the patrol in years was 248 feet high! And the main bulk of the icebergs is always under the water. The depth of a berg seventy-five feet high is about 300 feet.

Last season a procession of bergs, turning like a great merry-go-round of the sea, was one of the strange sights encountered by the patrol boats. A swift, narrow stream of icy water, running along the Grand Bank—a 500,000-square-mile submarine plateau off the coast of Newfoundland—and meeting the warmer currents from the south, formed the vast whirlpool. Single whirling icebergs, like giant dervishes, are seen more often. In the course of six weeks, one berg was carried by an ocean eddy in a circle whose diameter was more than fifty miles!

The time may not be far off when collisions of vessels with icebergs will be almost unheard of. Then, instead of sailors patrolling the frigid seas to keep track of the monsters, experts will penetrate the north to blow them to bits.

Here Are Correct Answers to Questions on Page 60

1. Broadly speaking, chemistry deals with what things are made of, while physics deals with the properties or qualities things possess without regard to chemical composition. But there are many scientific problems which involve both chemistry and physics, so there is no sharp dividing line between the two sciences.

2. A vacuum is emptiness. When we say a vacuum exists inside a bottle or in regions beyond the earth's atmosphere, we mean that, so far as we know, the bottle or the outer region contains nothing we can measure in any way. That would be the meaning of the term if we could create a perfect vacuum. Actually, no perfect vacuum is known to man. The best vacuum we can obtain by the most advanced methods still contains large numbers of gas atoms.

3. Both alcohol and mercury expand when heated, so if you put either of these liquids into a bulb opening into a narrow tube, a rising temperature will expand the liquid and force it up the tube. The sensitiveness of the thermometer to temperature changes can be regulated by the relation of the size of the bulb to the diameter of the hole in the tube. The larger the bulb and the smaller the hole, the greater will be the liquid's rise for each degree of change in temperature.

4. Both are heat engines. In the steam engine, the heat energy in the fuel is first transformed into the energy of compressed gas by heating water until it becomes steam. The steam pressure then acts to move the piston in the engine's cylinder. In the gasoline engine, the fuel's heat energy is converted into the energy of compressed gas in the cylinder itself by exploding the mixture of gasoline and air.

5. The motion of any point on the water's surface, when a series of waves passes that point, is up and down. The surface water does not move in the direction of wave travel except, of course, in exaggerated cases where waves curl over and break on top. In a sound wave, on the other hand, the motion of the air atoms is only in the direction of the wave, so that a sound wave consists of a series of areas where the air is slightly compressed, alternating with a series of areas where the air is slightly rarefied.

6. Water does not run uphill when you siphon a liquid from one tank to another. It appears to do so because it flows up the pipe above the level of liquid in the container from which you are doing the siphoning, but actually it is being forced up by air pressure. A siphon will not work unless the discharge end of the pipe is below the level of the liquid being siphoned. The down-flowing column of water, being longer than the upflowing column, weighs more, so that the pressure at the top of the pipe is less than the weight of the upflowing column. Atmospheric pressure therefore forces water up the pipe.

7. It has been found that an extremely thin sheet of gold, if held before a strong light, will allow a small amount of greenish light to pass through.

8. The energy of the gasoline is first converted into heat to expand the gases that drive the piston. The mechanical power thus developed moves the car along the road and, in doing it, friction develops in the bearings and also in the tires as they roll along. Only a small portion of the theoretical energy in the gasoline is turned into mechanical power and, at the end of the ride, practically (Continued on page 144)

Here Are Correct Answers to Questions on Page 60

(Continued from page 143)

all of the power actually developed has been wasted in the form of heat.

9. The light-sensitive photographic plate is coated with a layer of gelatin containing silver bromide. No one knows exactly what light does to silver bromide. Chemical analysis before and after exposure shows no change, but the area of bromide acted on by the light is reduced by the developing agent to extremely fine particles of metallic silver, while the developer has no effect on the bromide that has not been exposed.

10. "Cold light" is the term scientists use for light not accompanied by heat waves. Some day, when we have learned how to manufacture cold light, our lighting bills will be but a small fraction of what they now are, for even with the most efficient lamp we have today only a fraction of the power fed into it is converted into light waves. The rest is wasted in heat.

Test Answers—See Page 52

COMPARE your answers to the fifty statements in the test on page 52 with those listed below. If all your answers agree, you are a pronounced extrovert. If twenty-eight or more agree, your tendencies are extrovertal. If twenty-eight or more are in disagreement, your tendencies are introvertal.

1.	Yes	No	26.	Yes	No
2.	Yes	No	27.	Yes	No
3.	Yes	No	28.	Yes	No
4.	Yes	No	29.	Yes	No
5.	Yes	No	30.	Yes	No
6.	Yes	No	31.	Yes	No
7.	Yes	No	32.	Yes	No
8.	Yes	No	33.	Yes	No
9.	Yes	No	34.	Yes	No
10.	Yes	No	35.	Yes	No
11.	Yes	No	36.	Yes	No
12.	Yes	No	37.	Yes	No
13.	Yes	No	38.	Yes	No
14.	Yes	No	39.	Yes	No
15.	Yes	No	40.	Yes	No
16.	Yes	No	41.	Yes	No
17.	Yes	No	42.	Yes	No
18.	Yes	No	43.	Yes	No
19.	Yes	No	44.	Yes	No
20.	Yes	No	45.	Yes	No
21.	Yes	No	46.	Yes	No
22.	Yes	No	47.	Yes	No
23.	Yes	No	48.	Yes	No
24.	Yes	No	49.	Yes	No
25.	Yes	No	50.	Yes	No

Study Radium Poisoning

SEVENTY-FIVE physicians and industrial workers met in Washington, D. C., a few weeks ago to seek means of preventing radium poisoning among workers painting luminous dials on watches. Because a majority of the workers who were poisoned in New Jersey are believed to have "eaten" the radium by pointing their brushes with their lips, one suggestion was that brushes be supplanted by a stylus.

Studies are planned to determine what sort of health characteristics are best suited to working with radium paint.

I Am Learning to Be a Flyer

(Continued from page 30)

about steering. None of *them* had said it was easy.

"You must remember that every time you work the rudder, you must move the stick. If you should turn the rudder without tipping or banking the ship, it will slip. The worst mistake you could make would be to bank the ship one way and give it the rudder the other way. There is no easier way to send a ship into a spin.

"Now I will explain what these controls do when you work them. Take the stick. Glance out at the wing surfaces. At the rear edge of the wings, out toward the ends, you see that a narrow strip of the wing has apparently been cut away and put back with hinges. Those strips are called ailerons. When you push your stick to the right, the ailerons on the right wing go up, those on the left wing go down. With the ailerons you correct your ship when it is struck by up and down air currents, and with the ailerons you bank your ship when you wish to make a turn or a sideslip."

I INTERRUPTED: "Why would you deliberately sideslip?"

"Sideslipping," Jordanoff answered, "is one of the quickest ways to lose altitude. Toward the end of your course you will learn to make sideslip landings. They are useful sometimes in landing in a small field or when the wind is not just right. Now, if you will look back, I will explain the elevators and the rudder."

I turned around and looked down the blue fuselage at the ship's tail.

"The flat horizontal surfaces on either side of the rudder," said Jordanoff, "are the elevators or flippers. The surfaces to which they are attached are the stabilizers. The stabilizers are not controlled by the stick, but are set before—or during—a flight according to the weight carried. Watch the elevators. Pull your stick back."

I did so. The elevators went up. "Now push it forward." I obeyed. The elevators went down. It really did seem absurdly simple. When you pushed the stick forward, the flippers went down. The air striking them would naturally make the tail go up and the nose go down.

"Now the rudder." That was the simplest of all—on the ground! When I pushed the right pedal, the rudder swung to the right. When I pushed the left pedal, the rudder swung to the left.

JORDANOFF next explained the instrument board. It contained an ignition switch and two dials, an altimeter, which registered altitude in hundreds of feet—the needle was now at zero—and a heat gage. Pasted on the instrument board was a typed warning:

THIS IS A GOOD MOTOR. DON'T ABUSE IT! CRUISE BETWEEN 1,300 and 1,400 RPM.

"This motor," Jordanoff explained, "is water-cooled. Down on the left side near the floor you will find a little lever which works the shutter on the radiator. This particular motor works best at a temperature of 160 degrees. Just above that lever you will find another."

I found it—a steel lever with a small rubber handle working in a quadrant.

"That is your throttle. It corresponds to the accelerator on an automobile. When you push it forward, it feeds more gas; when you pull it back, it feeds less gas. Now—do you understand everything?"

I nodded, but I wasn't sure. It didn't seem possible that the operation of an airplane could be so simple, so understandable.

Jordanoff was standing on an aluminum foot plate on the lower wing. He had an envelope in one hand, a pencil in (Continued on page 146)

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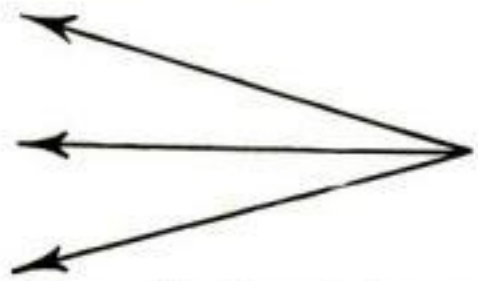
(Continued from page 145)

the other. On the back of the envelope he drew three lines, as follows:



On the upper line, he marked 90; on the middle line, 60; on the lower line, 0.

"The upper line," he explained, "is your maximum climbing angle. When you climb at that angle with the throttle wide open, you are using the full horsepower of your motor. When you try to climb at a greater angle, you are giving the motor more work than it can do, and the ship stalls.

"When you are flying horizontally—the middle line—you will use, for cruising, sixty horsepower—perhaps a little more or less.

"The lower line is your gliding angle. At that angle, your motor is throttled down and you are using, theoretically, zero horsepower.

"Just below your instrument board on the right you will find an iron handle about three inches long. Now it is pointing straight down. With it the gas is turned on or off. Down is off. Pull it up slowly until you feel it click."

I did so. The handle was now horizontal.

"Did it click?"

"Yes, sir."

"THE gas is now on." He called to a mechanic, who went to the propeller.

"Gas on. Switch off," said Jordanoff.

The mechanic began slowly turning the propeller. He must have turned it a half dozen times—pumping gas into the cylinders. He stepped back and shouted:

"Contact!"

"Contact!" Jordanoff repeated, as he reached in and turned on the ignition switch.

The mechanic gave the propeller a jerk. It swung back and forth but nothing happened. Jordanoff turned the switch off.

"Switch off!" called the mechanic.

"Switch off," Jordanoff repeated.

I recalled what the Department of Commerce doctor had said in examining my ears. The first purpose of a flyer's ears, he said, is to hear clearly when a mechanic says "Switch off" and "Contact." If the switch were left on when he twisted the propeller, the motor might start up. To be struck by the blade of a whirling airplane propeller is almost certain death. All over Curtiss Field are signs: KEEP AWAY FROM THE PROPELLERS!

Presently our motor sputtered, coughed, and roared. A blast of wind swept into my face, in spite of the thick celluloid windshield above the cowling in front of me.

Jordanoff had his hand on the throttle. He was pushing it forward and back, racing the motor, slowing it down. He reached into the forward cockpit and pulled out a worn old helmet from which dangled six or eight feet of flexible metal hose. He explained that the hose was a speaking tube. The tube forked; one fork ran to a little disk sewn into the helmet over the approximate position of each ear. At the other end of the tube was a rubber mouthpiece. Through this tube he could talk to me, above the roar of the motor; but I could not answer. It didn't seem quite fair.

WITH the motor throttled down, we could still talk by raising our voices. Jordanoff asked:

"Do you know what makes an airplane fly?"

I answered: "I think (Continued on page 147)

A definite program for getting ahead financially will be found on page four of this issue.

I Am Learning to Be a Flyer

(*Continued from page 146*)

so. The air from the propeller pushes backward. That makes the plane go forward. In going forward, the wind against the slanted wings makes them lift the plane off the ground and keep it in the air."

"Not quite," said Jordanoff. "The wind shooting past the wings creates a partial vacuum on their upper surfaces. This vacuum permits atmospheric pressure literally to support the plane in the air. Ninety percent of the 'lift' is atmospheric pressure. Only about ten percent is due to the rush of the air against the under side of the wing. Are you strapped in?"

I wasn't. I hadn't even seen a strap. I found it now—two ends of a stout web strap. The buckle consisted of a hinged curved bar of steel and a steel ring. You hooked the bar through the ring, snapped it back, and it stayed that way despite tugs and jerks—until you unfastened it yourself.

Jordanoff was climbing into the forward cockpit. Then all I could see of him was his head. The motor roared. A mechanic braced himself against the left lower wing, to aid us in making a sharp turn out of the line.

The motor roared in bursts. We were bumping along the ground with a great deal of noise. Except for the motor's roar, we might have been bumping along a bad country road in a farm wagon. Jounce! Bang! Crash!

We were taxiing to the end of the field. I was on my way to my first airplane ride, my first flying lesson! But I wasn't as nervous as I had expected to be. I had expected to be numb with fright. But my senses weren't working very well. I heard the roar of the motor, felt the jouncing, and saw things going past. My vision was blurred. My stomach felt tight. I recalled what one of the advanced students had told me: "Wait till he holds up his hands the first time, to show you you have full control! Your stomach will cuddle right up to your tonsils!"

WE REACHED the end of the field, made a sharp turn into the wind, and stopped. The motor was idling. A voice, deep and foreign, boomed into my ears:

"When I ask you a question, shake your head for no; nod it for yes. Nod if you understand, shake if you do not. Is your motor hot enough?" He was looking back at me.

I looked at the gage. It was 160. I nodded.

"Is the radiator shutter closed? If so, open it."

I reached down and pushed the little lever forward.

"Keep your hands and feet clear of the controls until I tell you." He looked back. I understood. I nodded.

Jordanoff seemed to settle down. I tried to relax. I said to myself: "Don't forget. Always relax."

The motor roared. We began to move. It was just like taxiing. Except that, by imperceptible degrees, I discovered that we were no longer jouncing. The brown grass was flying by beneath us. Suddenly something else flew by beneath us. I recognized it as a hangar.

That was what the first few seconds of flying were like—to me. I had no sense of leaving the ground. The ground merely left us.

SUDDENLY I was looking down the right wings at the ground. That was a bad moment. I knew that we were banking, turning. I knew that I must follow the ship through, no matter what maneuver she made. But I found myself stiffening, longing for her to be back on an even keel.

Presently she was, but my stomach was high within me and shrinking. Everything was blurred and confused. The propeller was blowing a winter gale in my face. I looked at the altimeter: 200 feet. (*Continued on page 148*)

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(Continued from page 147)

I watched the needle. It was near 1,000 when a voice boomed:

"Observe the relative position of the horizon to the nose of the ship. We are no longer climbing. Find out where your horizon belongs and always keep it there." He looked back. I nodded.

The ship bumped. It continued to bump now and then. It was similar to taxiing—going over a bump in a bad road. I noticed later—much later—that every time I flew over a macadam road, on a sunny day, no matter how high my altitude, the ship bumped. It bumped as badly at 2,000 feet as at 1,000 or 100. The hot road was sending up an air current. Flying over hills, cities, railroad tracks, and plowed fields, it is generally rough. Over smooth fields, it is generally smooth.

The deep voice of Jordanoff: "Place your hand lightly—very lightly—on the stick. Place your toes lightly on the pedals."

Very gingerly I did as I was told.

"Follow my movements."

My hand was shaking. Perhaps it was cold. I felt the stick twitch ever so slightly to the right, twitch back to where it was. I felt no movement of the pedals whatever. To my amazement, we were in a sharp bank and turning rapidly.

The stick twitched again. Again I felt no movement of the pedals. But we were flying level and straight once more.

"I will now show you what happens when you try to climb too fast."

THIS sounded ominous. It was. I felt the stick come back. The horizon sank as our nose went up. It seemed to me we were climbing straight up. Suddenly the motor seemed to go dead. It made a strange noise and the roar was followed by an awful whirring.

I knew what was happening. "Chic" Gaver had told me what happened when you climbed at too steep an angle. You stalled. In stalling, you lost all speed. Your ship became, not an airplane, but so much dead weight. We were falling through the air!

The horizon reappeared suddenly. It seemed to shoot up. My stomach tightened up a little more. A calm voice said in my ears:

"We are diving. The ship is out of control. The controls will not become operative again until we are diving fast enough for the wind to affect them."

I stopped being so nervous. I thought this was great. It occurred to me that the airplane is wonderful. It did things for itself. You climbed too fast: you stalled. The weight of the engine pulled your nose down: you dived. You were presently diving fast enough for the controls to work. It was great, all right—if there was room enough between you and the ground to pull out of the dive!

I looked at the altimeter: 800 feet. We were out of the dive, sailing along beautifully on an even keel again. I was thrilled. I could even relax a little. I knew I was going to like flying. The voice of Jordanoff broke into my enthusiastic thoughts:

"You will now take the controls."

THIS time my courteous instructor did not look around. I shouted: "Not yet! Wait! Hold on!" But it is useless trying to talk into the blast of ninety horsepower.

Jordanoff's hands were above his head. My right hand was on the stick. My feet were on the pedals. I was flying the ship! My stomach was feebly protesting. It didn't want me to fly—not yet.

I was amazed that the ship continued to fly on her course. She should have slid off to one side or gone into a tailspin.

The voice: "You are over-controlling."

I relaxed my clutch (Continued on page 149)

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(Continued from page 148)

on the stick. Then came Jordanoff's voice:

"Your nose is too high."

I pushed the stick forward. Down went the nose.

"Your nose is too low."

I pulled the stick back. When the horizon came to where it seemed to belong, I held it there.

"Your left wing is down."

I tipped the stick to the right. Up came the left wing.

"You are not flying straight but in a wide circle. Pick out some object on the horizon and fly for it."

I tried to. Have I said that the horizon was very hazy? It was. It was hazy and its haziness was rendered more so by the fact that, in looking at it, I was looking through two layers of thick celluloid, the windshield in front of me and the windshield in front of Jordanoff. I saw a dark cloud and decided to steer for it. It was to the left. So I pushed the left rudder.

The cloud skidded so far to the right that I lost it.

The voice: "Release controls!"

I released them gladly. I had given the rudder too generous a kick. It seemed to me we were skidding. We certainly were!

It had taken us just that long to stumble upon my worst fault—my footwork. My feet were dumb. They had utterly no rudder sense. They were probably the dumbest pair of feet that ever went up in an airplane.

Further trials only affirmed the same discouraging fact.

WE PRESENTLY returned to Curtiss Field. When we had taxied to the line and the motor was shut off, Jordanoff said:

"Not bad at all. Not half bad. Of course, we may have to try flying you with your shoes off until you develop more rudder sense. But perhaps not."

I felt that he was letting me down easy. I was certain that I would never learn to fly. There was little enough to do, but—how well you had to do that!

I had expected to come back from that first lesson trembling with terror. I was trembling, but not with terror. I was mad. Mad at the plane and mad at myself. Mad, most of all, at my feet.

It was comforting to learn that most beginners come down from their first few lessons mad clean through!

COULDN'T you just feel that dizzy skid away up there, as Larry's "dumb feet" gave her the rudder? Next month you'll ride with him again. In his vivid, brilliant, story, this young student pilot will let you share with him more of the stirring first experiences at the controls of an airplane. It's too good to miss.

Named the "Best Flyer"

WHO was the world's best aviator of 1928? The International League of Aviators has just named Col. Arturo Ferrarin, Italian ace, for that honor, which Lindbergh won in 1927. It is a popular choice, based on the longest nonstop flight of history which Col. Ferrarin made last summer from Rome to Brazil. Accompanied by the late Major Carlo P. Delprete, he flew 4,417 miles to establish a mark that airmen of all countries are still trying to beat. Previously, he had set a world's duration record.

United States honors went to Carl B. Eielson—pilot with Capt. George H. Wilkins on his flight last year from Alaska to Spitsbergen over the top of the world, and then in Antarctica with Wilkins.

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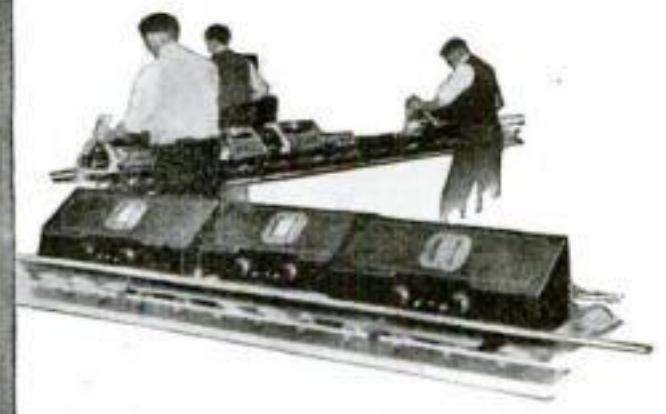

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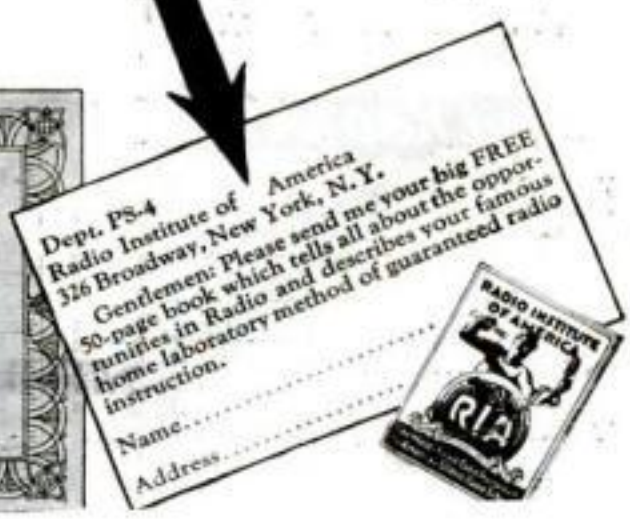

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The Real Fathers of Flight

(Continued from page 44)

going up, the old glider was ready for practice, and the new machine would be worked on during rainy or windless weather.

Wilbur, on October 4, wrote to his father that the new shed, forty-four by sixteen by nine feet, was about finished. There had been two days of first-class gliding last week, with the longest flight lasting forty-three seconds, which was a slight improvement over last year and also a world record. Soon, wrote Wilbur, they would raise the record above a minute, for they could now hover almost stationary in a favorable wind. Hovering was a feat beyond all previous experimenters. Wilbur emphasized to his father that there was less danger in gliding than before and all precautions were taken by Orville and himself.

ANOTHER letter from Orville to his sister on October 12 mentioned a great storm lasting four days. It told how the writer, in a twenty-five to thirty-five mile wind whizzed straight up in the air, and in bringing down the glider slammed Wilbur on the head and smashed the wings at one end. Also one wing of the new machine was being completed and to this brief reference Orville could not help adding a touch of exultation in a three-word phrase of children who term anything immense or delightful as "whopper" or "wopper."

I regret that I must abridge for the reader the voluminous Wright letters and diary records of thousands of words pertaining to their momentous campaign of 1903, a great and thrilling series of unpublished documents that lie before me.

One of the best letters, full of quips and merry nonsense, decorated with humorous sketches, was written on October 18 by the usually sedate Wilbur to his sister. It tells mainly of a gale that almost wrecked the camp building and sent five vessels ashore along the Atlantic coast, one within sight of Kill Devil Hill. The brothers, abed, feared that their incomplete rocking domicile would crash down on them. Toward four A.M., with the floor partly under water, they hustled to apply interior braces to their structure. Then the tar-paper roofing began to fly off. Orville donned Wilbur's overcoat and with a ladder went outdoors to mend the imperiled roof. The wind blew him backward some fifty feet, the tails of his coat standing out like wings, as illustrated by the writer's sketch. Wilbur went to the rescue and helped to set up the ladder. As Orville perched on the roof edge with hammer and nails, he was put in chancery by the wind-driven coat being folded tightly over his head. Another sketch illustrated his plight, laughable in retrospect, but serious enough when it happened. Orville himself said afterward that he could hardly drive his hammer against the savage pressure of that gale. Happily, the camp building was saved.

CHARLEY TAYLOR, now tending the Wrights' bicycle shop in Dayton, received a lot of news and banter direct from Kitty Hawk. Orville was the principal source, often cramming several hundred words on a post card. A festive card of October 20 describes their work on the flying machine in the language of Wall Street: "Stock was quoted at 208 yesterday morning but fell to 110 at noon." This was due to temporary misbehavior of the old glider. In reference to Charley's complaint that he felt unsteady on his legs, Orville advised that he brace his legs with the Pratt truss used on the airplane and here is a little diagram to show how to do it!

Octave Chanute and his protege, Dr. George A. Spratt, who had (Continued on page 157)

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(Continued from page 156)

seen last year's performance of the Wright glider, had been invited by the brothers to visit camp about November 5 for the expected trial of the power machine. Chanute was a civil engineer of Chicago, a designer of experimental gliders, a cheerful Moses who indefatigably scouted the trail to aviation's Promised Land but did not see it when it lay before his eyes! Dr. Spratt was a young amateur who gave the Wrights a useful hint on the reversal of center of pressure, which they verified with their wind tunnel. The doctor came on October 23, Chanute on November 6. It was too cold for the elderly Chanute, although the anxious hosts stuffed rags in all cracks of their building and kept a roaring wood fire in a stove improvised from an old carbide can. He left camp, shivering, on November 12.

THE power machine seemed under a hoodoo of bad weather and accidents. There was a lockout of the sole camp employee, Dan Tate, who sojered on his chore of fetching firewood despite his liberal stipend of $1.25 a day when the local wage scale was fifty cents. Dan lost a place in history along with his job.

At the first ground test of the airplane, the steel tubing shafts of the propellers twisted out of shape in a few seconds.

"Too bad," we may imagine Dr. Spratt's sympathetic murmur. "Well, you think Charley Taylor can fix them. I think I'll go home—been here two weeks now—though I would like to stay and see the first flight of your ship. On my way home I can express the shafts to Dayton from Norfolk."

"Thanks, Doctor, very good of you," the grateful Wrights doubtless responded to this offer. The Doctor went with the shafts on November 5. He did the helpful errand and, like Chanute, missed the big show of the third week in December.

Charley Taylor in the bicycle shop brazed the cross arms of the old shafts onto new ones of gas pipe. Meanwhile the brothers did some practice sailing with the old glider and hugged the carbide can stove to keep warm. The new shafts arrived on November 21 and two days later Orville wrote to Charley saying he had done a bang-up job of brazing and everything. It was fine that the bearings were not hurt. At the test the engine was pretty jerky because two oil-filled cylinders missed fire and in ten seconds both sprockets for the chain drive worked loose. Well, continued Orville, while there is life there is hope. They just applied the standard old remedy for all mechanical ills, Arnstein's bicycle cement, guaranteed to cure anything between a stop watch and a threshing machine. Did it work? Why, it just froze those sprockets in place. Also the engine now performed nobly. Stock in the flying machine was soaring.

HOWEVER, a sickening accident befell on November 28. The engine was speeding merrily in its test when—smack!—a bit of metal flew off one of the new shafts. Winter was near, two months had been spent in a sandy desert, it was a thousand miles and two weeks' round trip to the home machine shop.

We can see a young man of slight but wiry build, a suitcase in each hand, trudging through four miles of ankle-deep sand from a camp shed to the hamlet of Kitty Hawk. He stops often to rest on the lonesome, clogging trail. He arrives, takes a boat for Elizabeth City, N. C., there counts the meager bills in his purse, gets a night's lodging at a cheap hotel, curbs a hearty appetite to save funds, and in the morning buys a railroad ticket for Dayton, Ohio.

"Not a nickel left (Continued on page 158)

The Real Fathers of Flight

(Continued from page 157)

for carfare," mutters Orville on arrival at the home town. "Well, I can walk."

He lugged the weighty suitcases a mile and a half to the Hawthorn Street house, astonishing father and sister with his unheralded appearance.

"Well, I'm here," he stated. It was a fact.

About a week later, on December 9, Orville was boarding a train to return to Kitty Hawk with new shafts made of solid steel—something different from tubing and gas pipe, that would withstand the playful spite of whizzing propellers. He bought a newspaper and read a dispatch from Washington, D. C., to the effect that the flying machine designed by Prof. S. P. Langley, Secretary of the Smithsonian Institution, had crashed in the Potomac River at the time of launching from a house boat. Over $70,000 of Government and other funds had been spent on the ill-fated attempt.

DOUBTLESS Orville felt a momentary chill as he read. On the heels of this monumental failure, he and his brother Wilbur were aiming to succeed. What chance had a pair of self-taught bicycle men, who had not spent one tenth of $70,000 in all their aerial research to prove the validity of dubious dreams?

The Wrights' diary tells that Orville arrived in camp on Friday, December 11, and that next day there was an abortive test of the machine on its starting track, a sixty-foot monorail of iron-shod wood. Sunday, as usual, was a day of rest. At 1:30 P.M. Monday, says the diary, a signal was set for the men of the Government life-saving station who were to lend a hand. Five men came and helped carry the machine up Kill Devil Hill and to lay track on a slope of eight degrees fifty minutes.

The brothers tossed a coin for the first ride and Wilbur won. He climbed in and lay on his stomach. There was trouble with the releasing device. It was fixed up. Wilbur shot forward prematurely, Orville clinging to the right wing struts and running alongside as fast as he could go. At forty feet the younger brother had to quit and then snapped his stop watch. The machine had lifted a bit, six or eight feet from the end of the track. Now at a distance of some sixty feet from the track it was about fifteen feet above the ground. It lost headway and shortly came down on its left wing, breaking several pieces of the wooden frame, including one skid. The excited Wilbur forgot to stop his engine for some time after landing. The flight lasted three and one half seconds and covered one hundred and five feet.

"WELL, boys, the dingus flies," we may imagine a sun-tanned brawny life-saver saying to his mates. "Don't know what use it is. Give me a boat or a buggy for travel."

Only that it might confuse the record and upset the agreed-on fable which is history, I refrain from the assertion that man made his first flight in an airplane on Monday, Dec. 14, 1903. Let us wait patiently for the official date three days later.

Wilbur sent a short wire to his father reporting the initial flight; misjudgment had reduced distance; success was certain.

The brothers were rightly confident, for they had now proved the last doubtful point—efficiency of propellers. This came up to the figured sixty-six percent, or a third more than Maxim or Langley had attained.

Tuesday was spent on repairs. These were completed by Wednesday noon and the machine was set on its track in front of the camp for a try-out on the level. The wind was too light for an attempt. As the brothers awaited a proper breeze, a stranger wandered up from nowhere and said:

"What do you call (Continued on page 159)

The Real Fathers of Flight

(Continued from page 158)

this thing—flying machine?"

"Yes, it is a flying machine," Wilbur (I believe it was) admitted.

"What're you going to do with it?"

"We expect to fly in it when conditions are favorable."

"Well," remarked the stranger after walking around the machine with eyes of keen appraisal, "I should think that thing might fly—when the *conditions* are favorable."

All the citizens of Kitty Hawk had been informally invited by the Wrights to view a flight the next day, Thursday, December 17. A few years later crowned heads and crowds of a quarter million folk thrilled over the same marvel, but the virgin voyage of the airplane drew only a couple of spectators. The natives were hardly enough interested to be skeptical. Perhaps the brothers had a shrewd thought to insure privacy by asking everybody to come around. The abysmal ignorance of the natives seems laughable until we reflect that the wisest of scientists were then little better informed, regarding the air as a gas but not as a highway.

THE inventors themselves, despite their proven science and the success of their first aerial hop, had moments of passing doubt. They knew; yet who knows anything? They had shaved death with a light glider. Now they would ride a mechanical bird as weighty as a piano, forced through the atmosphere with the thrust of a dozen wild horses. Men had been killed by falling with gliders only house-high. A drop of a few feet with the power machine might finish rider and ruin hopes.

Thursday was sunless and wintry. A chill wind blew. Ice floes were visible along the shore of Albemarle Sound and some whitecaps on the Atlantic Ocean whose surf drummed the beach half a mile away. The long strip of white sand between ocean and sound was spotted with ice-skimmed gray pools of water. A leaden sky with drifting cloud-wrack harmonized with the bleakness of the scene below. At intervals gulls shrieked, eagles and fish hawks soared or darted dizzily.

The man-made bird on the sand was no match in grace for its rivals overhead. It was much larger. Its cream-colored wings spanned forty feet with an area of 510 square feet. There was a twin vertical rudder behind and in front a twin horizontal rudder of forty-eight square feet, but a spectator could hardly tell which end went first. The rider would lie on his stomach between the main wings, flanked by engine and by whizzing propellers, using hands and twisting hips in a movable cradle to balance and guide the craft.

WILBUR WRIGHT was thirty-six and Orville thirty-two years old at this time. They were in their physical and mental prime. The height of the elder was five feet, ten and a quarter inches, that of the younger just one and three fourths inches less. Their weight was nearly equal at 145 pounds, which saved trouble in calculating total load for the machine. Their oval faces were smooth shaven. Wilbur had a prominent aquiline nose, firm thin lips with incipient upward lines at the corners, a little baldness at the forehead. Orville's hair was yet thick and curly, brown with a hint of red. Both had grayish-blue eyes, keen, quick, and frank. Their voices were alike, soft and quiet, similar in tone, Wilbur's more inclined to staccato. They were swift in physical action, deft and nimble.

Athletes of a delicate type, they felt the biting cold of that historic day and could not withstand it like the hardy natives. They had to run indoors frequently to get warm over their carbide can stove, filled with blazing driftwood. They slapped arms, danced and jumped in the nippy (Continued on page 160)

The Real Fathers of Flight

(*Continued from page 159*)

wind outside. After all, they had no sort of flying costume, not very warm ordinary clothes, and could not wear overcoats during the virgin flights.

Five persons who came as aids or spectators witnessed the airplane debut. They were John T. Daniels, W. S. Dough, and A. D. Etheridge of the life-saving station; W. C. Brinkley, a lumber buyer of Manteo, and Johnny Moore of Nag's Head, a sixteen-year-old who stumbled upon more wonder that day than the luckiest Boy Scout has ever chanced upon since. Johnny's name will not perish. He was there!

At 10:35 A.M. in a north wind of twenty-seven miles an hour, Orville boarded the roaring craft for the first ride, rose ten feet or so, scooted uncertainly up and down owing to a difficult control of the ill-balanced front rudder, and came to earth about a hundred feet from the track end. The time was about twelve seconds. This was, in truth, the first flight of aviations' accepted birthday.

AFTER minor repairs, Wilbur, at 11:20 o'clock, made a flight of about 175 feet.

Orville had the third trip at 11:40 o'clock, reaching an altitude of about fourteen feet and about the same distance as his brother. The merit of the lateral control was happily shown when the left wing hit the ground first.

At noon Wilbur embarked on the fourth and last flight. The craft jogged up and down for three or four hundred feet, then the pilot leveled it to a fairly even course. Smoke and flame belched from the open exhaust. Snarling propellers and bellowing cylinders drowned the shouts of the excited spectators. The prolonged explosive tumult reverberated between sand dunes and leaden sky, alarming the loftily soaring eagles, warning them that their exclusive dominion was over and that winged man would soon chase and outstrip them as they now chased and caught lesser birds. On, on sped the airplane. It was 800 feet from the start when it came to a small hummock. Perhaps the ridge caused a down-gust or rut in the aerial highway. The craft wavered, began to pitch up and down as at the start, then quickly darted to the sand. Only the front rudder frame was damaged.

THE flight was 852 feet in distance over the ground, and the time was fifty-nine seconds.

A few minutes after the voyage the airplane, which had been placed alongside the camp shed, indulged itself in a festive somersault with the aid of the wind. It was partly smashed. You can see this very craft today in the Science Museum at London, where the King of England and many thousands of his subjects have been viewing it during the last year. Let us hope that with an end to an unseemly and senseless dispute, this precious American trophy will be brought to its proper home in the National Museum at Washington.

A certain telegram belongs with the airplane. When his sons left home that year, Father Wright gave them a dollar with the remark:

"Now let's hear from you when there is news."

The dollar was a good investment, it brought the following result:

The Western Union Telegraph Company
Via Norfolk Va., 176 C KA CS 33 Paid.
Kitty Hawk N C Dec 17
Bishop M. Wright, 7 Hawthorne St.
Success four flights thursday morning all against twenty one mile wind started from Level with engine power alone average speed through air thirty one miles longest 57 seconds inform Press home Christmas. Orevelle Wright 525P

An operator's error chopped two seconds from the time of flight and the Government anemometer at Kitty Hawk made the wind a little brisker than stated in the wire.

The Biggest Engineering Job Hoover Ever Tackled

(Continued from page 38)

War, he developed a great coal and cement property at Tong Shan. This involved running a railroad to the coast, building a harbor. And then the career spreads as wide as the world, so that I can touch only the high points.

Let us finish with Australia. A few years after Hoover took service with the Chinese Emperor, he was back again, this time at Broken Hill, Australia, where lay an immense area of very low-grade zinc ore. Months and years of experiment with flotation processes, of close figuring on the separate branches of the enterprise, and Hoover had created for his stockholders one of the largest and soundest mining properties in that corner of the world. Asia, where he first sank his teeth into a really big new job—where he had his early, romantic adventures with exploring new country and standing siege from the Boxers—called him back again and again. When, in 1914, he dropped mining engineering for human engineering, he probably knew that continent better than any other except his own.

HIS old associates best remember, for its technical and human interest, his "lead job" in the Burmese jungle some thirty miles above Mandalay. This, like an even bigger job in Siberia which he laid down when the war broke, was geologically a twin to our own Leadville. Long ago, the Chinese had scooped out from this wild ground a wealth of silver-bearing lead carbonates. That ore is always an oxidization from deeper-lying bodies of more refractory ores. There may be only a thread remaining from the process of oxidization, or there may be a bonanza. Hoover and his men located the parent body in a certain hill. They had first to run a railroad through a most difficult country. This job, and especially the item of bridging by ingenious means of their own a seemingly unbridgeable chasm, brought episodes of which they are telling stories yet.

They got their American machinery assembled and ran a tunnel into the hill. But the ground was "heavy"; timber would not hold. They took to masonry. The same problem when they ran into the great ore body. They solved this by an ingenious system of pillars and of filling in with material sent down shafts from above. By similarly original devices, they generated their own power and sanitated the district to make it habitable for a working force. Before they finished, they had dipped into almost every branch of engineering. And they had built up in the jungle a busy, healthy, and prosperous community of twenty-five thousand.

BESIDES minor enterprises, Hoover had a main hand with the management of four great properties in the gigantic Russian Empire—a gold mining company under the Arctic Circle in remote Siberia, a copper company in the Caucasus, another lead and silver proposition on the Irkutsk River near the border between Siberia and Turkestan, and finally a most complex business at Kyshtim on the Russian side of the Ural Mountains. Here lay an enormous principality, rich in forests and in large bodies of low-grade copper and iron. The lords of this land had been trying vainly for one hundred and fifty years to make it pay. The company for which Hoover was executive took over the development of all these resources collectively. By most expert technical work, by saving and utilizing a score of by-products, by coördinating everything, it put the estate on a basis of low but steady dividends.

This job, coming late in his private career, is important not only as illustrating how Hoover's work grew from simplicity to complexity, but how it was flowing (Continued on page 162)

The Biggest Engineering Job Hoover Ever Tackled

(Continued from page 161)

over into the field of human engineering. The work required expert technical personnel. And Hoover's company, managing somehow to evade the Czarist prejudice against educating the masses, put virtually all the population to school. Some day, as they developed and trained executives and technicians, they hoped to withdraw their Americans, leaving the job entirely to the Russians. When the war broke, this enterprise supported, in a comfort and enlightenment they had never known before, some 175,000 people. It carried on through the Czarist stage of the war; but Bolshevism paralyzed it. Kyshtim, in 1922, was one of the famine districts which Hoover's men relieved.

So much, in a few strokes, for Asia. To finish his roster of continents, he worked on the northern and southern tips of Africa—jewel mines in the Sinai peninsula, gold in South Africa. In Western Europe he had relations with reduction works in Belgium and Germany, and accepted the interesting job of running down for the Italian government the Roman iron mines of the Alps. And from his home office in San Francisco, he worked on our continent with Southern California borax deposits, oil-pipe lines, and British Columbian gold mines.

THE world knows his big jobs since 1914. I merely repeat that the constantly expanding operations of mercy, by which he directed the feeding of two hundred millions of people, had the engineering cast, as well as that human touch which never fails in Hoover's work. Finally, the job with the Department of Commerce illustrated, for perhaps the first time in human history, how high engineering practice, without conflicting with democratic institutions, might be applied to the whole business of government.

By pure coincidence, he comes into his administration at a time when our Government has facing it more straight and obvious engineering jobs than ever before in its history. There is the enormous task of revising the flood protection of the Mississippi River. There is the sound but extensive plan, which Hoover has been boosting in the Department of Commerce, for internal waterways. There is the problem of a deep-sea outlet from the Great Lakes to the Atlantic. Finally, we are approaching the point when the Panama Canal can no longer handle the traffic. We must either parallel it with another ditch or dig a new canal—probably across Nicaragua.

YET his administration may put all these jobs soundly on foot, and still leave behind it another memory which will last longer in history. He brings to the White House, as he did to the Department of Commerce, the dawn of a new conception in government. The pattern of our industries is shot with black streaks which represent enormous waste—nobody's fault, just a flaw of growth. The same thing holds, probably, for the pattern of our Government. What we may yet call political engineering tries to eliminate those spots by coördinating the whole structure. The method, as already practiced by Hoover in the Department of Commerce, does not recognize compulsion as a tool. It tries to accomplish its ends with as little legislation as possible. It conceives of government as an onlooker who from a high position can view the whole field, see the flaws invisible to dwellers in the valleys, and accomplish correction by enlightenment and persuasion.

That conception of engineering method as applied to government may be Hoover's supreme contribution not only to his own nation but to human history.

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Cannonball Baker, Automobile "Broncho Buster"

(Continued from page 51)

hour, stopping only for gas and oil (and water for myself). That track was as hot as a griddle; there wasn't a breath of wind to ease the rays of a midsummer sun. About eleven P.M., when I was well in the lead, and everything seemed to be rolling my way, a swarm of gnats settled over the track. The tiny insects began splattering against my goggles; they'd stick there, and as soon as I'd wipe them off, another batch would come at my glasses like water out of a hose. Finally, one of them shot past the corner of my goggles, and landed *smack* in the corner of my eye! A harpoon couldn't have hurt worse. The pain drove me frantic, and before I knew what had happened, my machine was headed for the top of the bowl-shaped track. In another yard it would have crashed through the guardrail and probably have killed half a dozen spectators. I jerked the front wheel 'hard about', as sailors say, but the movement was too abrupt. I was hurtled through the air, my bike tore ahead like a crazy rocket—and when I regained consciousness I was in the accident ward, with one eye blinder than a mole. The gnat had been removed, but the doctor told me it had paralyzed an optic nerve, and that only careful treatment would bring the eye back to normal.

WELL, as I lay there all banged up, I started figuring how I could get back into that race. I reckoned that if I could average seventy an hour till morning, I'd still have a chance at the prize. So I turned to the medico and asked him if my machine had been injured much.

"Why no," he said. "It's in the pit, and in better condition than you are right now."

That was enough for me. "Doc," I said, "I'll be back for breakfast." Then I bounced off my cot and started for the track, steering with one good eye. The medico thought I was crazy, but I was never saner in my life. I wanted that first-prize money, and I wanted the satisfaction of knowing that I could *take a fall and still keep going!* During the next seven hours I whirled around that track like a marble in a cup, and when eight A.M. arrived I had hung up a new track record of 1,534 miles. With both eyes open I'd have done 200 miles better than that.

After I had made certain I could take a long-distance licking, I conceived the idea that I could be of service to automobile manufacturers who wanted to give their product the severest possible testing under actual road conditions. A thousand miles of road test is worth ten thousand miles of laboratory analysis. So I broached my proposition to R. E. Olds, designer of the Reo and the Oldsmobile, and one of the great geniuses in the automotive industry.

"WHAT is the hardest test you can think of?" he asked, after we had talked over my plan.

"A transcontinental run," I replied. "Among other obstacles lying between the two oceans are a couple of mountain ranges, a sizzling desert, and about 2,000 miles of terrible roads."

"What's the existing record, Cannonball?"

"Eleven days and seven hours." Then I added, "And I think I can clip a day or two off that."

Mr. Olds promised me a bonus for every twenty-four hours I could clip off the old record. Until this time the transcontinental drive had been regarded as a two-man job; one man driving while the other slept. But I figured that I could make better time alone. Col. Lindbergh has the right idea about this "Lone Eagle" business, too. You go farther and faster when you travel solo.

I started from Los Angeles on May 16, 1916, and my tough luck (Continued on page 166)

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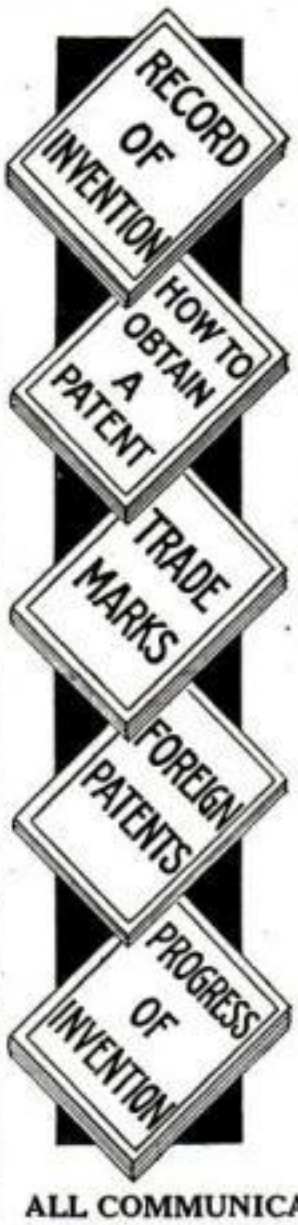

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Cannonball Baker, Automobile "Broncho Buster"

(*Continued from page 164*)

commenced almost immediately. Crossing the Mojave Desert with the sun baking everything at 120 degrees, I had to change tires five times in eighty miles. On the second day out, my oil pipe shook loose, became detached, and I lost all my oil. Between Arizona and Missouri, everything rolled along fine; but the black mud in Missouri and Kansas nearly ruined my chances. A cloudburst transformed the soft roads to quagmires, and things got so bad that I covered only ten miles in two hours. Once I came to a place where a dozen autos jammed the road ahead of me. Teams of horses were dragging them out one by one, and I figured I'd be held up for ten hours anyway. In desperation I hit upon the plan of *pulling around* the jammed cars by cutting out of line and ploughing through a hayfield. In mud up to my hub caps, I churned around for a bad half hour, but finally pulled out onto the road, ahead of the bogged automobiles. Still, even through the mud, I beat a letter posted in Emporia, Kansas, to New York City. You can bet I traveled during that last 1,500 miles! I did it in two days, and reached New York City just seven days, eleven hours, and fifty-two minutes after I had started. I had covered a distance of 3,471 miles—and had slept only seven hours while doing it!

SPEAKING of sleep, I find that a little goes a long way with me. But when I do get drowsy, I never allow myself to doze at the wheel. That's the one sure way to catastrophe. I just pull up into the side of the road, take a catnap for half an hour, and then awake much refreshed for my next hop. After my transcontinental trips, I usually sleep about eight hours and then feel fine. When not actually racing, I train like an athlete, and although I'm forty-five years old I seem to be getting better all the time.

I knew I could better my own coast-to-coast record considerably, and began at once to make plans to do so. But in the meantime I took some short trips, just to keep in trim. I drove a stock Rickenbacker over the Alleghenies in midwinter—from Indianapolis to New York—a distance of 778 miles in twenty-two hours. That was the coldest ride I ever took.

After this, I took a flyer at Hawaii, which, they told me, had the toughest ninety-mile motorcycle course in the world. Well, that course *was* tough and no mistake. It circled the island of Oahu, a volcanic mountain with a thousand peaks. The road took in every one of these peaks, and at times would drop down sheer cliffs, just like a waterfall. I circled the island both ways, going from right to left, and then counter-clockwise, just to show I could do it with either hand. My best time was made in the clockwise direction. I covered that ninety-mile course in two hours and four minutes—and half the time I wasn't on the road at all. Four other chaps who have since tried to better my record have landed in the hospital; a fifth, I understand, bounced right off a mountain peak into the ocean.

FROM Hawaii I took a jaunt to Australia and annexed six consecutive records on one 500-mile road race. That was the greatest number of records I ever broke in twenty-four hours, although I regard the day as lost when I haven't smashed at least one or two previous marks. Other fellows come along and break my records, and then I have to turn around and shatter theirs. It's getting harder to improve the other fellow's performance these days, but there's still one or two worth while marks left to shoot at.

The greatest of these is of course the coast-to-coast record. I hold that now with my latest performance in a (*Continued on page 167*)

Cannonball Baker, Automobile "Broncho Buster"

(Continued from page 166)

Franklin. But it took me thirteen years to make it. After I established my seven-day record in 1916, Jack Mulford came along and clipped twelve hours off of it. Then I turned around and in 1920 drove a car under the auspices of the U. S. Army Recruiting Service from Washington to Los Angeles in five days and twenty-two hours. This record stood unshattered for three years until a private citizen whisked a Studebaker over the same route in five days and thirteen hours. This made me pretty cross. It was all right for a professional like Ralph de Palma or Jack Mulford to take me for a fall, but to be licked by an amateur was too much! So I determined to beat the existing record—not in a passenger car, but in a truck!

I loaded up a two-ton GMC with Atlantic sea water, and exactly four days and twenty-three hours later dumped that sea water into the Pacific Ocean. That happened in 1925, and my record stood unchallenged till I recently hurled a Knight across 3,453 miles in exactly seventy-three hours. That beats the railroad running time for the same route, and definitely proves that the modern automobile can stand the racking strain of a forced pace over all kinds of roads.

DURING my last trip, I didn't raise the hood once; nor did I make a single tire change. Ten years ago it was enough to prove that an auto could make the distance. Now it's necessary to demonstrate that it can make the distance without a single repair.

What's the longest journey I ever made? Oh, a little tour that I call my "All-Capital Run," in which I touched the capitals of forty-eight states and covered 16,234 miles in eighty days. I'd duck into a state capital, roll up to the Governor's mansion to shake hands with the chief executive, and say a word or two in favor of good roads. Naturally I'm a booster for better roadways. I believe that eventually the Atlantic and Pacific coast will be linked by one national highway, broad enough for four cars abreast. When that day comes, and it's pretty near at hand right now, we'll be crossing the continent in less than forty-eight hours. Airplanes—watch out!

The record I'm proudest of is my latest nonstop mark between Los Angeles and New York *and back again*, a distance of 6,692 miles. In covered-wagon days it would have taken eighteen months to make that jaunt, but I did it in a Franklin in less than a week. My elapsed time for the round trip was 157 hours and twenty-three minutes, or just about 6½ days. Yes, I had a companion on that trip to spell me when I needed a wink of sleep. But during that whole week I slept exactly nine hours. And what do you suppose I ate? Nothing but salted peanuts! I find that they are the greatest energizers, and the handiest thing a man can eat during a gruelling strain. I consumed nearly twenty pounds of them while setting my greatest transcontinental record.

IF YOU look at a map, you'll see that I traveled in an air line between the two coastal cities. I wanted to beat my own previous time and the combined running times of *The Chief* and the *20th Century Limited*, the two fastest trains in the world. To do this, I couldn't afford to deviate from the crow-flight course, no matter where it led me. From Los Angeles I shot straight across the sandy plateau of Arizona into Albuquerque, New Mexico; from there I drew a bead on Dodge City, Iowa—a run of 600 miles. Three hailstorms nearly pelted me off the road, and 100 miles of gumbo mud pretty nearly broke my heart. I had to run thirty-five miles in low gear through the heaviest of the mud—but by some mile-a-minute driving between

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Cannonball Baker, Automobile "Broncho Buster"

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Kansas City and St. Louis, I managed to land in the latter city some five hours ahead of my own record. In crossing the Alleghenies I lost this five-hour lead, in a cold fog that made every turn a lurking menace. But the worst was yet to come. When I hit Philly, I got tangled up in the maze of early evening traffic and as I progressed through the numerous New Jersey towns that dot the road between New York and Philadelphia, the density of traffic forced me to limp along at twenty-five miles an hour. I like to travel fast—but I'd rather be chief engineer of a brick scow than hit a single pedestrian or smash into a family car out for an evening spin. By respecting the New Jersey speed laws, I missed the Tottenville ferry (just outside of New York City), and my chance for a new transcontinental record went glimmering.

You can bet I was disappointed when I reached New York City in seventy-four hours, an hour behind my own previous time. But I determined to turn right around, streak back over the same route, and make a new record for a two-way passage. Luck was with me this time; heading west, records fell like ninepins; and I rolled into Los Angeles exactly ten hours ahead of the old mark. I had beaten the best trains in the world by a full day, had consumed 527 gallons of gas, twenty-three quarts of oil, and 250,000 salted peanuts! That last figure is one that will never be beaten.

I'VE talked a lot about my long rides, but so far haven't said anything about my short ones. In other words, my mountain-climbing trips, which usually aren't more than ten miles from base to summit. Probably the most dangerous and often attempted climb is that of Mt. Washington in New Hampshire. I regard this climb as the single most treacherous stretch of road in the world, Pike's Peak not excepted. Many drivers, amateur and professional, have been killed in the attempt to scale Mt. Washington in an automobile, Jack Grant being the last and most famous driver to lose his life on that final forty-three-percent grade.

Up until September 30, 1928, the record was held by my old friend Jack Mulford, who had covered the distance of seven and eight tenths miles in seventeen minutes flat. On the morning of September 30, the betting was heavily against me to better Mulford's record. The fact that the Tip-Top House at the peak of Mt. Washington was three miles above the clouds, and could be reached only by traveling up a curving, precipitous incline, made Mulford's time seem almost unbeatable to those who were unfamiliar with my technique. Most drivers have to see the road ahead of them for at least ten yards, but if I can see the radiator cap, I can usually manage to pick my way. But on the morning of my ascent, the fog was so dense that I could barely see the front end of my Franklin Special! I started off from the Toll House at the foot of Mt. Washington, slipped my car into high gear, and made a mental resolution not to take it out of high at any point during the climb.

I NEARLY broke that resolution! For as I reached the level of the clouds, I saw that they were inky black; thick as wool, and just about as impervious to light. My headlights were of no service at all, and there I was streaking up the side of a mountain, whirling around "S" curves, and hanging over yawning chasms, at fifty an hour! After ten minutes of climbing I knew I must be near the top; still I could not see a foot ahead of me. The road suddenly seemed to go straight up ahead of me, the onward rush of the car abated, and reluctantly I was reaching for my gear shift, when I almost ran into a chap waving a big red blanket.

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Cannonball Baker, Automobile "Broncho Buster"

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"Hey, Baker . . . Stop" he cried. "You're here! You've reached the top!"

I jumped out of my car and shouted: "Did I break the record?"

"You certainly did, Cannonball. Your time is fourteen minutes forty-nine and three fifths seconds."

I grinned happily as I turned the car downhill. "Want a ride down?" I shouted at the official timer.

He declined with thanks. But he needn't have, because I didn't break any records going down that hill.

Flyers Open the World's Ice Box

(Continued from page 25)

Contrasted with the Arctic, there is little fog in the region of the southern pole. The air above the ice is almost vaporless. The light is often a blinding glare that hides the contours of the ground and makes it difficult to see the hummocks and depressions in the ice. The North Pole is practically at sea level, in the midst of a frozen sea. The South Pole is located on solid land nearly 10,000 feet above sea level. To reach it, aerial explorers have to fly at the efficiency-reducing altitude of 12,000 feet to clear the mountains that bar the way.

The depth of the ice mantling the plateaus and mountains of the frozen continent can only be guessed. A sensitive, 150-pound instrument may provide definite knowledge. It is similar to the sonic depth finders used on ships to determine the depth of water by recording the time required for an echo of a sound to return from sea bottom. This instrument will make "soundings" at different points on the ice sheet to discover the character of the land below.

MANY mysteries are locked under this ice. For instance, there is evidence that what is now the world's coldest spot was once partly tropical and contained flourishing forests. Perhaps there once lay across the Antarctic a "continental bridge" by which animals and plants traveled between Africa and South America in an early geologic period. The man who can lift the ice cap and peer beneath may discover fossils and formations that will reveal the part the continent played in the past. Modern expeditions can transport scientists of the party by air to exposed spots, if any are discovered, so they can make a detailed study of the rocks.

There are other questions to be answered. Does a mountain range reach toward the Pole from Graham Land, and is it a continuation of the Andean Cordilleras, which form "the backbone of South America"? Is the Antarctic continent, as some geographers believe, really two islands instead of a single continent, with the split connecting Ross Sea and Weddell Sea? There is also the possibility that in some sheltered valley the warmth may be sufficient for strange forms of life to exist. "Somewhere," Commander Byrd has said, "in those tremendous areas, there must be lowlands where temperatures rise sufficiently to permit vegetable and animal life. . . . In some Antarctic valley, perhaps shut in by towering mountains, a thrilling discovery may await us."

IN THIS latest attack in what Shackleton called "the White Warfare of the South," the world is sharing the thrill of discovery with the explorers. Radio, playing a stellar röle, is carrying to all parts of the world a running story of events as they happen.

A definite program for getting ahead financially will be found on page four of this issue.

Sh!—They're Filming "Talkies"

(*Continued from page 81*)

rehearsed scene. Everything went smoothly. The dialogue came through clearly and well-modulated. Smiles appeared on the faces of director, sound expert, and actors only to disappear suddenly.

"Rrrrrrrrrrrrrr!"

A noise like a tornado tearing the roof off a barn roared from the loudspeaker.

"What on earth is that?"

A hasty phone call to the monitor room. Play back stopped. A quick consultation between director and sound man, the script of the play before them.

"Ah, that's it," said the director finally. "That tornado was Walter (the actor playing the hero's rôle) tearing off his little corner of newspaper!"

Another quick conference. What to do? Tearing the paper is essential to the action; it can't be cut out. The director had an idea.

"Moisten the corner of that newspaper and see what'll happen."

This was done. "Silence!" Three bells! On with the play!

THE scene was retaken. In another play back the paper-tearing was inaudible.

The cost of this little mishap, the sound man explained to me, was about $500. And this shows how valuable the play back really is. Had the scene been filmed directly the horrible noise would have remained undetected until after the developing process and the tearing of the inch-and-a-half bit of newspaper might have meant a loss of $10,000!

This, I found out, was but one instance of the difficulties encountered in the "talkie" studio in reproducing ordinary noises of everyday life needed in the action of the picture. The firing of a gun or the barking of a dog will not record truly. The technician whose task it is to create "realistic" sounds, I learned, was called the "effects man." It is his job to produce the ingenious devices that make sounds seem natural in the finished "talkie." The simplest odds and ends, such as tin cans, bits of string, old bottles, and the like are used in making these sound-imitating devices.

An actor's stage experience is of little help to him in the "talkies." Instead of using the full voice, as on the stage, you have to talk in low, distinct conversational tones or the play back will make you sound like a hawker at a country fair. Incidentally, it is a weird sensation to hear yourself talk in soundproof surroundings. Because all echoes and reverberations have vanished, your voice sounds lifeless; your words seem to die almost as they leave your lips. Another difference is that you may not walk about while delivering your lines. Instead, you must make all movements the action calls for, then stop within range of a "mike" to voice your speeches.

THE tiniest details have to be watched and listened for. For example, one of the office scenes had to be repeated many times before it was discovered that one of the actors, while talking, stood too close to a desk which, despite its felt padding, threw back his voice and created an echo in the play back. And as for coughing and sneezing—they are unpardonable sins in a "talkie" studio!

Yet, despite all vigilance and infinite precautions, it often requires an entire working day to take one little scene which will run from three to five minutes on the screen.

I hadn't been at the studio long before, one noon hour, I prevailed upon the sound expert to explain how the film or sound-track process works.

The kernel of the matter is photographing variations in light intensity on a film. The sounds—the

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Sh!—They're Filming "Talkies!"

(Continued from page 170)

actors' voices, instrumental music, or what you will—are picked up by the "mikes" on the stage, which change sound vibrations into electrical vibrations. These are carried by wire to the sound department, where they are amplified.

The amplified "speech current" actuates an electromechanical light valve in the sound-recording machine between a ribbon-filament projection lamp of constant intensity and a rapidly moving film. The alternations in the speech current cause the valve to open and close like a camera shutter. The original sound vibrations thus are translated into corresponding variations of light and recorded on the film. This record is in the form of a band of narrow cross lines of varying shades between clear white and black. The sound ribbon, as it is called, is later printed on the finished moving picture film.

Sound and vision synchronization during the final "shooting" of the "talkie" is effected through a distributor which provides an exactly equal flow of current to the motors that grind the cameras on the stage and those that drive the sound-recording machines in the sound room. They move together, keeping step like soldiers.

Now, when the "talkie" film is shown at your theater, what really happens is a reversal of the process that took place when it was made. The film, containing both picture and sound in a photographic record, is run through an ordinary motion picture projection machine to which has been attached a sound-reproducing unit. This unit includes a light that is reflected upon the sound record of the film.

As the sound record passes across this light, it interrupts the constant glare shining through it, causing variations of light and shadow to fall on a photo-electric cell, which has the property of changing these variations back into corresponding electrical vibrations. The latter are amplified and carried by wire from the projection booth to reproducing horns placed behind the screen and the horns translate them into sound. Result: you hear your favorite movie stars speak their lines!

Two Important Flights

TWO great flights by two famous pilots were recent events of important significance to the future development of aviation.

One was the 2,000-mile trip of Col. Charles A. Lindbergh in piloting the first air mail from Miami, Fla., to Colon, Panama Canal Zone. The other was the record-breaking nonstop flight of Capt. Frank Hawkes across the continent from Los Angeles, Calif., to Roosevelt Field, N. Y.

Lindbergh's journey, following a time schedule with his usual precision, marks a definite step in the fulfilment of plans for linking the countries of the Western Hemisphere in a network of air lines—plans which a year ago seemed almost visionary. It opened a new commercial service to the Canal Zone, with stops on the way. Eventually it is planned to extend the system from Panama southward along the east and west coasts of South America.

Captain Hawkes, veteran air mail and racing pilot, drove his Lockheed-Vega monoplane through storms across the country in eighteen hours, twenty-one minutes, and fifty-nine seconds, bettering by about thirty-seven minutes the nonstop record established last year by Arthur Goebel and the late Harry Tucker in the *Yankee Doodle*.

Added significance was given to these two achievements by the recent prediction of W. Irving Glover, Second Assistant Postmaster General in charge of Air Mail Service, that within five years the air mail will serve every city of 20,000 population in the United States.

Locking Out the Heat and Cold

(Continued from page 75)

the usual large sheets. These smaller pieces make handling easier and also help eliminate the cracks which are likely to appear in plastering. One manufacturer makes them so that they overlap when put together. They also have beveled edges, so that V-joints are formed both vertically and horizontally. The overlapping gives a tighter job and the V-joints make for better plastering, as shown in Fig. 2.

While it was decided, after considering these points, that insulating board should be used, just how to use it was still a question. If it were used on the outside only, the elimination of sheathing and building paper would constitute a greater saving than would the cost of the lathing if it were used on the inside only. However, tests showed that a covering of sheathing and paper has some insulating value of its own, while lath embedded in plaster affords practically none. So to obtain the most insulation for the money a compromise was effected. It was decided to use the sheathing and building paper on the outside as usual and use insulating boards on the inside, plastering directly on them. Of course use on both the outside, eliminating the sheathing, and on the inside, eliminating the lathing, would in the long run have proved a more economical method of construction.

THIS took care of the wall surfaces. Next came the question of the roof, an important factor because of its unusually large area.

Either the roof surfaces themselves could be insulated or the ceilings below them. If the roof itself, the insulating boards could be applied to the underside of the rafters, leaving a good air space between the insulation and the shingles, or they could be put on top of the rafters, and then the shingle strips laid on these. Some authorities say that the greater air space obtained by placing the insulation on the underside of the rafters protects the shingles from dampness and this prevents their rotting.

When insulation is applied to the roof surfaces the attic space is made more comfortable both in winter and summer. But in the Riverside house the attic spaces were to be low and used mostly for storage. Hence it was unnecessary to go to the expense of covering the entire roof area when all the rooms below could be protected by covering the ceilings. Naturally the ideal way would have been to insulate both the roof surfaces and the ceilings, but it was decided as a matter of economy to do only the ceilings.

IF THIS house had been brick veneer on studs the problem of insulation would have been virtually unchanged, for insulating boards could have been used either to replace the sheathing directly behind the brick, or on the inside of the studs. If the walls had been of solid brickwork the boards could have been used on the inside with furring strips separating the insulation from the bricks. This would have prevented moisture from coming through to the plaster.

Insulation, of course, cannot overcome loss of heat through cracks around window and door frames where careless workmen have done a poor job. But a firm, tightly-constructed house can be made comfortable with insulation no matter what the outside conditions may be —and without exorbitant fuel bills.

In the case I have described, in spite of long wall surfaces exposed to severe weather conditions, the house has been comfortable at all times. And this was accomplished for only about $200 more than the construction would have cost without insulation. With the complete house costing, in round figures, $15,000, this proved not a high percentage to spend for an "extra" which supplied so much additional comfort.

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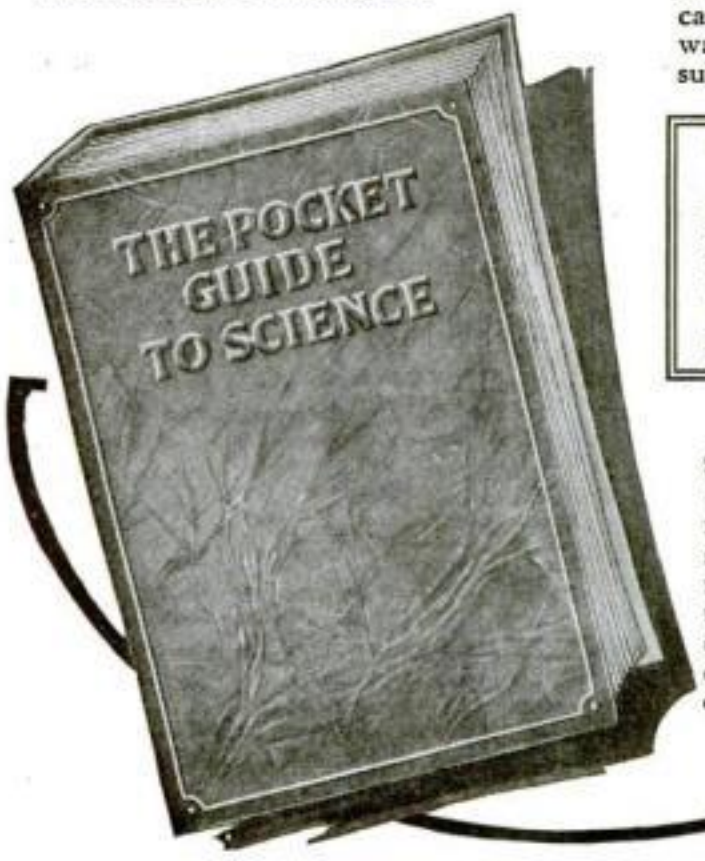

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If Your Headlights Went Out—

(*Continued from page 84*)

slippery. And lots of new drivers don't realize that the roads are much more slippery just after the rain starts than later, after the downpour has washed away the slime that forms out of the first drops when they mix with the dust on the road."

"But if you have chains on the wheels you can't skid," interrupted Considine.

"Yeah?" growled Gus. "I used to believe that, too, when I was just starting in. It cost me just thirty-eight dollars to find out it wasn't so. I had chains on, but I went around a curve too fast on some ice, and the next thing I knew the back of the car tried to get ahead of the front end. One rear wheel lammed into the curb and snapped the axle right off. Chains are a help. But you don't have anything like as much traction with 'em on ice as you have without 'em when the pavement is dry."

"But you're safe anyway if you go slow enough—and look at all the time you waste dawdling along," protested Considine.

"Rats!" snapped the grizzled veteran. "You're not safe at any speed on ice without chains, and what's the use of hurrying to save a few minutes when you stand a chance to earn a ride in a nice, fast motor hearse by doing it?

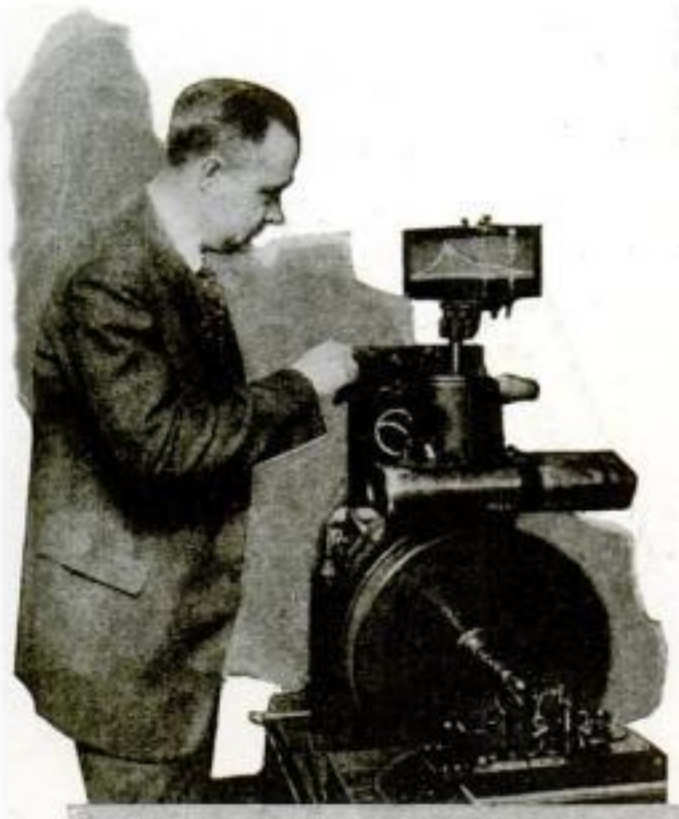
"AND besides," Gus continued, "when you do save a few minutes by taking chances you probably waste 'em right away bragging about it! Speed doesn't cause accidents, but speed at the wrong time does, so drive always at a speed that you know is safe. If there is any doubt in your mind, play safe—go slower.

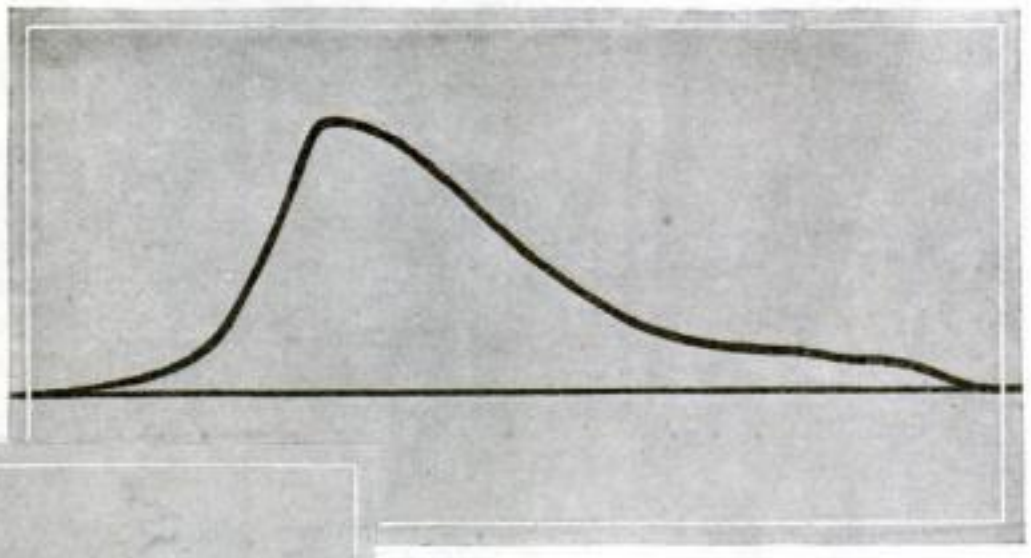
"Going slow isn't the whole story, either. You can be a regular old slow-poke and still take your life in your hands every time you go on the road, if you don't get wise to the biggest idea in safe motoring, and that is: Never take a chance on what the other fellow's going to do, nor on what he may think you're going to do. Don't depend on your horn—the other fellow may not hear it. Keep your eye on the cars ahead, and signal to the fellows behind what you are going to do.

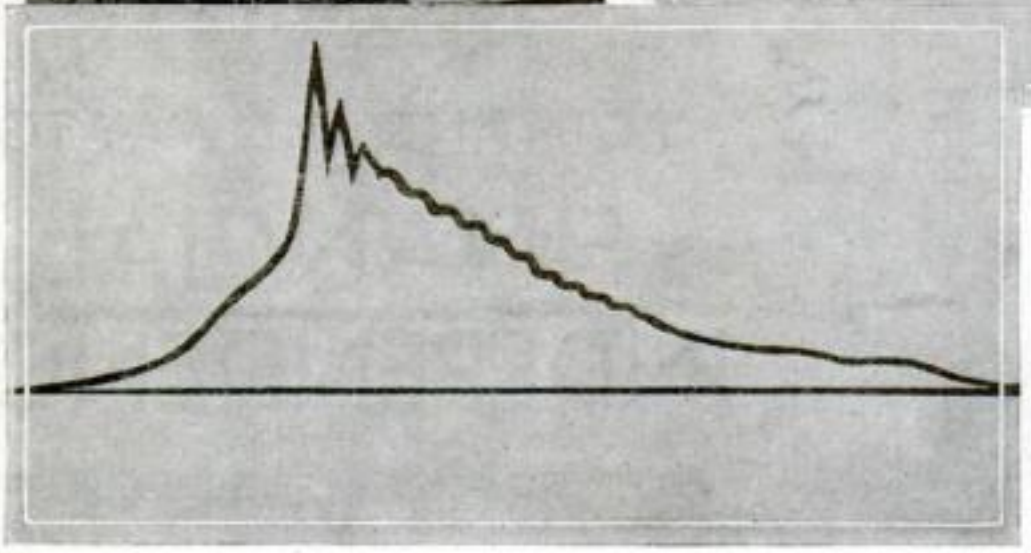
"THERE'S another angle to this safe driving business," Gus went on, as he stood off to observe the effect of his operations on the mudguard. "You want to remember that safety depends a lot on the condition of your car. Brakes should be just right and you certainly don't want anything wrong with the steering gear. I was in a garage one time when a hot-air merchant was grumbling to everybody about how loose his steering gear was. But he didn't do anything about it and a little later when he started out, still shooting off his face, the whole works came loose in his hands. Before he could stop, he'd busted into a tree and smashed his radiator. He didn't deserve any sympathy and, believe me, he didn't get it. The gang razzed him about it for years afterward!"

FOR more than three and a half years Gus and Joe have been giving readers of POPULAR SCIENCE MONTHLY the benefit of their long experience with motor cars. And each month these two veteran proprietors of the Model Garage grow more popular. Many readers have written that the mechanical advice offered by Gus in Mr. Bunn's entertaining stories have helped them solve difficulties which every motorist encounters. What is your particular problem? Let's ask Gus Wilson about it. Write to Mr. Bunn in care of Popular Science Monthly, 250 Fourth Avenue, New York City.

Did you ever see a picture of a "KNOCK"?







This is what happens in the cylinders of a gasoline engine when it is running smoothly. The pressure gradually increases after ignition until the mixture is nearly all burned. Then it grows less and less.

But when the gasoline is causing the engine to knock, just see what happens. Is it any wonder that the engine loses power? Ethyl Gasoline prevents that jagged saw-tooth.

THAT sounds peculiar, doesn't it? Yet we can get a perfectly good picture of the "knock" in a gasoline engine. Those two curious looking diagrams were taken with a Midgley Indicator and show the pressures inside the cylinder of a gasoline engine.

The one on the right is the pressure diagram of a normally operating engine, while the one on the left shows a "knocking" engine. So the "knock" really is the part of the diagram that looks like saw teeth.

These little diagrams were most important. Through them, the scientists in the General Motors Research Laboratories discovered that it was the *fuel* that "knocked"—not the engine. This fact established, they developed Ethyl Gasoline, whose active anti-knock ingredient is tetraethyl lead.

The end of the long research resulted in Ethyl Gasoline's being put on the market by leading oil companies. It encouraged automobile manufacturers to bring out the present high compression engines and to give the motoring public a new kind of motoring comfort and efficiency. It is called *high compression performance*.

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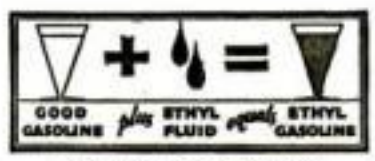

Knocks out that "knock"

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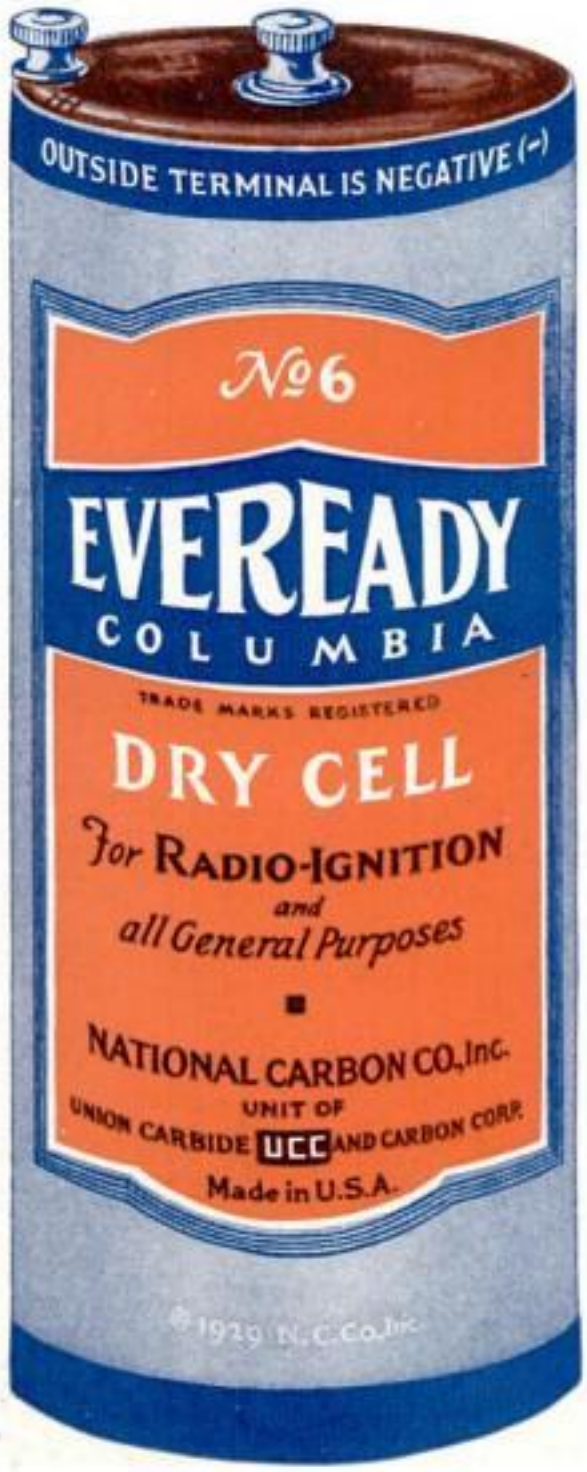

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